UNITED STATES ARMY
AVIATION DIGEST
SEPTEMBER 1964
U.S. ARMY
U.S. ARMY

UNITED STATES ARMY AVIATION DIGEST

SEPTEMBER 1964 VOLUME 10 NUMBER 9

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The mission of the U. S. ARMY AVIATION DIGEST is to provide information of an operational or functional nature concerning safety and aircraft accident prevention, training, maintenance, operations, research and development, aviation medicine, and other related data.

The DIGEST is an official Department of the Army periodical published monthly under the supervision of the Commandant, U. S. Army Aviation School. Views expressed herein are not necessarily those of Department of the Army or the U. S. Army Aviation School. Photos are U. S. Army unless otherwise specified. Material may be reprinted provided credit is given to the DIGEST and to the author, unless otherwise indicated.

Articles, photos, and items of interest on Army Aviation are invited. *Direct communication is authorized to: Editor-in-Chief, U. S. Army Aviation Digest, Fort Rucker, Alabama.*

Use of funds for printing this publication has been approved by Headquarters, Department of the Army, 27 November 1961.

Active Army units receive distribution under the pinpoint distribution system as outlined in AR 310-1, 20 March 62, and DA Circular 310-57, 14 March 63. Complete DA Form 12-4 and send directly to CO, AG Publications Center, 2800 Eastern Boulevard, Baltimore, Md. For any change in distribution requirements, merely initiate a revised DA Form 12-4.

National Guard and Army Reserve units submit requirements through their state adjutants general and U. S. Army Corps commanders respectively.

LETTERS

Sir:

Are wires a major flight hazard in Vietnam? No, but here at Fort Benning, especially in the many off-post maneuver areas, they are!

After a year's flying in the land of rice paddies and jungle-covered mountains, one is liable to forget all about wires and concentrate solely on a landing zone. Wires are practically non-existent in the "Old Country"; therefore, they are only a minor consideration.

I speak with experience because I have recently returned from Vietnam. After reporting to my unit, I was assigned to pick up six passengers for the purpose of making a recon of a proposed off-post maneuver area. After finding the area, the party wanted to land and make a recon from the ground in order to find a possible location for CP headquarters, a mess hall, etc.

I was so preoccupied with trying to do a good confined area approach that I practically landed right on top of 4 wires. I cut one wire and saw the others in time to stop the helicopter before I cut the other three.

Needless to say, the crew and passengers were "shook-up," and there was one less wire stretching across our beautiful countryside. There was no damage to the crew, passengers or aircraft, but the incident could have resulted in the loss of 9 people, 1 UH-1D IROQUOIS helicopter, four wires and possibly a few trees.

This is just one more reminder on a seemingly endless subject, but I for one will try to remember the following points of a low recon:

Forced Landing Areas,
Ground Conditions, Slope, Hazards,
Obstacles In Landing Zone
Entry and Takeoff Patterns.

LT JAMES N. LYNCH
11th Air Assault Division
Ft Benning, Ga.

Sir:

The article "Lost Communications Procedures" (July) was a most thought provoking one. Such articles provide basis for sound judgment on the part of the pilot when things do not go as planned.

In that this article was directed to the airborne member of the ATC team, it would appear that a sequel is justified relating to the ATC controller on the ground. Certainly every aviator wonders what possible action will be taken by the controller to achieve safe flight when two-way communications have been lost, i.e., what and how soon is action taken by the controller to insure clear airspace for an aircraft that loses communications on final approach, executes a missed approach, and immediately proceeds to the alternate.

LT COL R. H. McDONALD
Dept of R/W Tng, USAAVNS
Fort Rucker, Alabama

Sir:

Imagine my surprise when I looked at the July issue of the Army Aviation Digest and found a mechanic's picture on the cover, and a lead line indicating that there is an article of interest to the mechanics inside. Also, if you will, imagine my amazement, after reading the article and a more detailed review of the picture, to find that your example of a mechanic on the cover is using a tool which is not authorized in his toolbox. Namely, he is guilty of using an adjustable wrench, more commonly referred to as a "crescent wrench" by auto mechanics. The size of the wrench that he is using indicates that there should be an open-end wrench of the correct size in his tool box.

Now, I ask you, is THIS an example of the professionalism that you are trying to promote?

CARL A. PRICE
Sp-5
Line Chief

• *Have some more surprise: SM 55-4-4920-AO8, dated April 1964, lists 6", 8" and 15" wrenches, open-end adjustable, as components of tool set, organizational maintenance, Army aircraft, set C, FSN 4920-323-5037.*

Sir:

In the July issue of the Digest there was an article in Crash Sense titled "Summer Follies."

On page 44 the article leaves me with the impression that an increase in humidity (all other factors the same) would result in a loss of power.

I cannot buy this concept. I have always been taught that the reverse is true, up to a certain point.

Water injection in conventional as well as jet type engines is a recognized and tested method of *increasing* available power.

Water itself is composed of H_2O, which gives it an oxygen content of 33%. Air has only approximately 20% oxygen content. The vaporizing effect of water also has a tendency to lower intake temperatures which is an aid, especially in jet type engines.

Would you please print a correction if I am right, or must I change all of my previous concepts?

HOLLIS E. MOORE
Enterprise, Alabama

• *Mr. Moore's concepts are shared by many. Here are the facts:*

1. The oxygen content of water will not support combustion.

2. The oxygen content of air will support combustion.

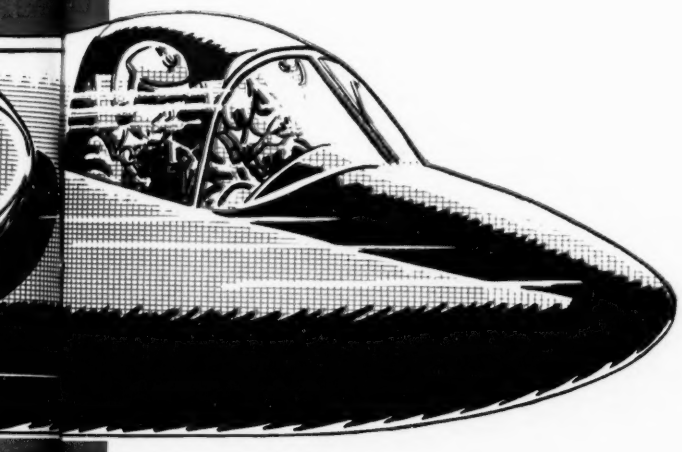
3. Water or water vapor entering an induction system displaces air and the oxygen in the air needed for combustion, thereby enriching the fuel/air ratio and causing a loss in power.

4. Water injection does not increase available power. It does suppress detonation and maintains lower cylinder temperatures, thereby permitting the use of higher power settings.

5. Humidity also affects turbine engines, but to a lesser degree. For example, under extreme humidity, a reciprocating engine may lose about 12 percent BHP while a turbine engine will lose about 3 percent under the same conditions. The reason for this is that the turbine engine operates with such a great excess of air that combustion is essentially unaffected by the humidity.

ARMY

V/STOL



Captain Richard C. Anglin

IF PRESENT research and development bears fruit, Army Aviators in the early 1970s may zip straight up into the ozone with a roar of thrust and a blast of dust to conduct battlefield surveillance flights in a new breed of V/STOL aircraft.

Combat reaction teams will mount V/STOL transports located in the same forested bivouacs and literally leap forward to engage or outflank the enemy.

Criticized in the past for its half-hearted approach to V/STOL development, the United States' effort is now making rapid technological advances. The military is leading the way. Projects sponsored by the Armed Services are narrowing the gap resulting from the European aviation industry's headlong plunge into V/STOL research.

Tri-service V/STOL transports such as the Ling-Temco-Vought XC-142 are in the pretest stages. The Army's radically new "pop and peek" aircraft, the Lockheed XV-4A Hummingbird and the Ryan-General Electric XV-5A, are *flying*.

It'll be a while before an *operational* V/STOL is flitting around the combat zone. But lessons learned from some 36 past projects have swelled the store of V/STOL technology and present research aircraft forecast possibly feasible solutions to historic obstacles.

THE NEED

V/STOL aircraft, with their freedom from asphalt and concrete, promise more widespread applications than any other avia-

tion innovation since the helicopter. Military planners foresee a significant effect on tactics and organization.

Capable of vertical flight from small, easily concealed areas, these new vehicles are planned to be so compatible to life in the boondocks that they may well replace the mess tent as the favorite adjunct to the CP.

Congressional leaders have added impetus to V/STOL development. According to Senator Mike Monroney of Oklahoma, "The biggest thing ahead of us in aviation is not supersonic transportation. The big advance of the future will be in traveling short distances in vertical takeoff and landing aircraft. . . . Headway is being made . . . if that program is successful, we will shortly see greater progress than we have seen to date."

Army tactical use of aircraft combining the loiter and approach capabilities of the helicopter and the speed of the fixed wing stirs the imagination. Perhaps the most apparent advantage of operational versions of such testbeds as the XV-4A and XV-5A will be their ability to give the ground commander unprecedented access to instant intelligence.

In the future, a field commander requesting information upon which to base immediate tactical decisions might well be answered with a nod, a swoosh and — presto, the observer is back from a look along the FEBA before the tent flap stops flapping.

Current surveillance equipment, coupled with electronic data transmission and processing devices, now offers a real time (electronese for "right now") battlefield intelligence capability. However, present reconnaissance aircraft have limited speed and maneuverability. Envision a conflict where hostile aircraft and a myriad of ballistic, inertial or heatseeking, morale destroying, projectiles fill the air. Under these conditions, aircraft survivability becomes a problem.

V/STOL vehicles, however, with their ability to duck, dodge and dart to reduce exposure, combined with sophisticated target acquisition and surveillance gear, promise the Army tactical commander a system of battlefield eyes and ears with an above par life expectancy.

Predicting the nuclear combat environment is chancy at best. One thing is certain — the ability to disperse becomes life insurance if your adversary can vaporize an entire airfield with one strike. V/STOL transports, living with the troops, as integral an item of mobility as the 2½-ton truck, will be able to deploy units at a moment's notice. They promise a new dimension for firepower and maneuver.

The case for dispersion was succinctly summed up recently by a leading aviation executive who stated, "A weapon of modern war should not be tied to acres of concrete which require tremendous effort and initial investment, attract aggressors as inviting targets, and are practically irreplaceable in the time span of battle."

THE OBSTACLES

The major stumbling blocks to obtaining a truly operational V/STOL aircraft are fuel/weight considerations, selection and design of a propulsion system, and the tricky business of transitioning from vertical to horizontal flight. Each of these areas has inherent penalties with which the designer must compromise. From an operator's viewpoint the ideal V/STOL vehicle would climb fully loaded straight up out of the pines, zip forward with a flash, and consume fuel at the rate of an O-1A.

Each V/STOL design concept has taken a different and ingenious approach to squeezing sufficient thrust for vertical lift and transition from existing jet or turbine engines; most of the aircraft, however, will have a prodigious thirst for fuel at low altitudes, presenting the familiar problem of range versus payload.

V/STOL operation brings with it the unique hazard of long and adrenalin expending periods of loitering in the critical condition of low speed/low altitude. In view of this, each major American project has cranked in the additional safety margin of multiengine propulsion. However, two engines make twice as much noise. The V/STOL advantage of being able to rise out of terrain concealment for a quick, low-level observation run may be offset somewhat unless the problem is solved of making their noise level less blatant, less betraying.

Not the least of the problems involved in V/STOL development, and one which prompts many to be critical of the concept, is ground impingement — the blast of rock and dust which results from using superheated and/or high velocity thrust forces to get the vehicle moving vertically. Just how compatible V/STOL aircraft are to life with the field soldier may depend upon a solution to this difficulty.

THE APPROACH

Some observers of V/STOL development glance apprehensively across the Atlantic where aircraft have been leaping off the ground vertically since 1961. They cite the Hawker-Siddeley P.1127, the Dassault Balzac V, the Mirage VTOL, the German VJ-101 and cry that we're losing

the race. But to have a race you usually have to be going in the same direction. The most publicized European efforts have been toward the development of a strike aircraft. The American aviation industry has taken a "prove the concept" approach with reconnaissance/surveillance and tactical transport vehicles.

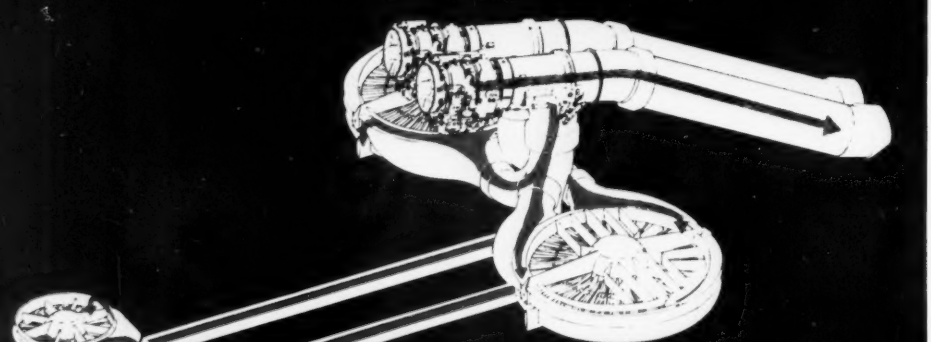
Although the desirability of a United States V/STOL strike aircraft is obvious, from strictly an Army view, the V/STOL vehicles under development in this country are types which might well replace the present generation of Army aircraft. Overseas designs have relied in the main on large thrust engines, brute force, to get them into the vertical mode. For vertical lift, United States V/STOL testbeds rely on multiengine design or on systems which augment or convert jet thrust.

Popular magazines have snickered at the United States V/STOL effort as being sporadic and disjointed: "We've got too many irons in the fire. Let's choose one aircraft design and get it to flying." But how do you select the best way to propel a mass of men and metal straight up? Theoretical debate won't do it. To this end the Army does have a research and development program with direction and purpose (and budgetary limitations). Aim of the program as stated by the Air Mobility Division, Office of the Chief of Research and Development, is to provide the optimum V/STOL aircraft at a price and with the simplicity, maintainability, and relatively low fuel consumption that will permit the Army to afford it and support it.

Over the years the Army has joined in a number of projects to probe the feasability of V/STOL. Present "fixed wing" R&D is focused primarily on six testbed programs, culled from a multitude of design proposals and concepts. Three of these, the XV-4A, XV-5A and XV-6A (P.1127), will be used to ferret out engineering data and operational experience for development of a new surveillance aircraft to replace the Mohawk. As an eventual replacement for either the utility/tactical transport or the light tactical transport, the Army is participating in a tri-service evaluation of the X-19, X-22 and the XC-142.

(Space restricts discussion to these testbeds, all essentially fixed-wing aircraft in conventional flight. To allay the fears of helicopter V/STOL advocates, it should be pointed out that the Army is concurrently peering into the possibilities of the compound helicopter. One, the

XV-4A Hummingbird hangs motionless in the air during first hover flights at Lockheed plant, Marietta, Ga.



Propulsion system of XV-5A showing cross-ducting of thrust from two J85 jet engines to drive lift fans in wings and nose

XUH-1B, has reached speeds of 222 mph. Tip turbine and hot-cycle rotor concepts are also being scrutinized.)

Determining an aircraft's capabilities from design drawings is analogous to judging a candy contest by reading the recipes. You've got to try a sample or two of the most promising. Hence the Army's *testbed* approach to V/STOL. Expected R&D results are future vehicles which are sturdy, simple, and sufficiently flexible to merit their cost in meeting uniquely exacting Army mobility needs.

THE AIRCRAFT
THE XV-4A

Small and pert, the Lockheed Hummingbird is claimed by its designers to be quick and responsive and, like its namesake, able to dart from a hover to forward flight. It is the first pure jet fixed wing aircraft developed by the Army. It is the first of the current United States military V/STOL programmed aircraft to fly.

Two of the stub-winged Hummingbirds have been built for the Army Transportation Research Command (TRECOM) to test the augmented jet ejector principle for vertical lift. This principle is the heart of the XV-4A concept. Jet exhaust gases from the two JT-12, 3,300-lb thrust engines propel the aircraft in horizontal flight. To get the bird moving vertically, engine gases are diverted through nozzles into fuselage mixing chambers. When doors are opened at the top and bottom of the fuselage the high velocity and resultant low pressure sucks down outside air which boosts the basic 6,600 lbs of thrust to 8,300 lbs, or a theorectical 1.4 times. The downward blast of air is a relatively frigid 300° F at the bottom doors compared to the 1200° F in the augmentation chamber nozzle area.

The 8,300 lbs of thrust resulting from augmentation eases the 7,200-lb gross weight Hummingbird up into ground effect (3-20 feet). At a hover and in the low speed flight regime where there is insufficient airspeed over the conventional control surfaces to achieve effective control, reaction nozzles in the nose and tail, fed with engine gases, and wingtip nozzles, fed by engine compressor bleed air, allow the pilot to correct roll, pitch and yaw.

Perched at a hover, the pilot tilts the aircraft nose downward to get a horizontal push from the ejectors, and the XV-4A begins to accelerate forward. At about 80 kt, which provides enough wing lift to support one-half the aircraft weight, the nose is rotated upward to give the wing a positive angle of attack. The pilot shifts one engine to forward thrust and the aircraft continues to zip forward to 120 kt. The second engine is then directed aft for maximum forward thrust. When the ejector doors are closed, transition is complete and the XV-4A is off and running to a design speed in excess of 350 kt.

Pilot controls in the Hummingbird are conventional — stick, rudder and throttle — for both flight modes. Aviator anxiety is soothed by a zero delay ejection seat. A modified Navy A4D seat is used, the Douglas Escapac I-C. A higher impulse rocket and zero delay lanyard were incorporated and the seat has been tested for a zero speed, zero altitude capability.

The first testbed aircraft was flown conventionally one year after program go-ahead was given by TRECOM. Eight conventional flights were made during July and August of 1962 with no attempt at outstanding performance. According to Lockheed, prime interest was in determining the conventional control characteristics of the aircraft. For safety, flying was between 10,000 and 15,000 feet at speeds below 240 kt. The 32-foot long Hummingbird reacted smartly during these initial takeoff runs, which ranged between 800 and 1,100 feet.

On 24 May 1963, the Hummingbird made its first vertical flight with a 300-lb lead weight attached between the landing gear to restrict the height of hover, looking like a member of a chain gang. Free hover with the weight removed was accomplished on 28 May.

Hummingbird test pilots took

an understandably wary approach to attempting the transition from vertical to horizontal flight. The aircraft was first flown in the vertical mode to a forward speed of 74 kt. Then, flying at 5,000 feet, the aircraft was slowed from cruise speed below the stall speed (about 110 kt) to approximately 55 kt, thus achieving a partial hover at altitude. This overlap transition accomplished, the first full transition was made on 8 November 1963.

Test pilot reaction to the Hummingbird was enthusiastic, "... the little bird is really ready to go somewhere in a hurry. After retracting landing gear and flaps it seems as if you are continually raising the nose to keep from exceeding the desired climb speed."

Six full transitions were made before the aircraft was demonstrated at the Army Mobility Symposium, Fort Benning, Ga., on 20 November 1963. When the Phase I contract was finished the Hummingbird underwent modifications indicated by the testing.

Phase II of the XV-4A project began this spring. During Army engineering flight testing at Marietta, Ga., the no. 1 aircraft crashed, killing a TRECOM test pilot. During the summer the no. 2 Hummingbird began full-scale wind tunnel tests at NASA's Ames Research Center, Moffet Field, Calif.

X-19

First of the tri-service V/STOL projects to be flight tested, the Air Force managed X-19, is a half-scale testbed built by Curtiss-Wright to evaluate the tilt-propeller concept. Four broad-chord, paddle-bladed propellers perch outboard on fore and aft wings, mounted high on a fuselage reminiscent of the U-9. They are driven by interconnected shafting from two 2,250 hp T-55 Lycoming engines mounted parallel inside the rear fuselage.

Propeller pods point skyward to lift the aircraft vertically and rotate 90° on the ends of the stubby wings to provide thrust for conventional flight. Flying forward, lift over the airfoils is supplemented by side or radial force from the high density, fiberglass props.

The X-19 was designed as a utility transport with a payload of 1,200 lbs or six passengers. However, its high wings and relatively unobstructed cockpit view promise possible surveillance applications in Army use.

Curtiss-Wright designers claim the two prototypes will have a snappy 400 kt max speed and cruise at 350 kt. The first aircraft was test flown last fall. First successful hover was achieved in early July.

The pilot controls hover, transition, and horizontal flight with standard stick and rudder. As the aircraft rises vertically and proceeds into transition, crisscrossed, mechanically coordinated variations in prop blade angles and thrust provide control. Powered through crossshafting and overrunning clutches, changes in blade angle between the two front and two rear propellers control pitch. Roll is handled by changing blade angles of both propellers on the left or right side. Varying the blade angle of diagonally opposite props controls yaw.

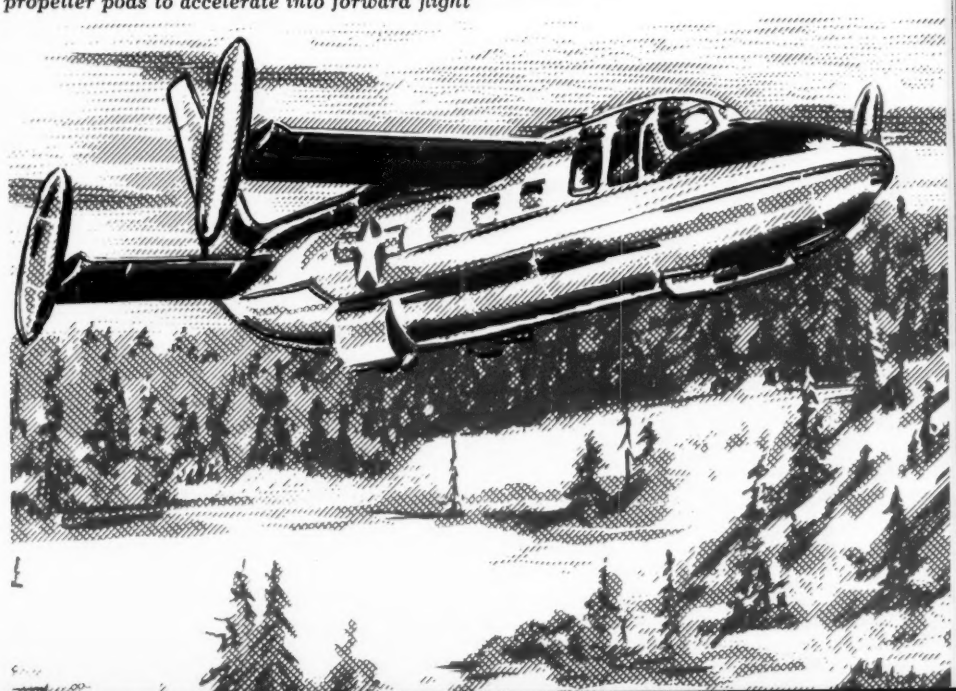
When transition is completed and the aircraft is scooting along horizontally, the method of control is shifted to ailerons, elevator and rudder. Single engine performance is claimed even in the vertical mode.

X-22

Bell Aerosystem's X-22, a Navy-managed, tri-service project, with its large ducted fans at each "corner" of the aircraft looks like a flying four-cup, teacaddy. It is an unusual looking vehicle, but it also has unusual design capabilities.

Four 7-foot diameter fans are mounted on the ends of extremely minimal fore and aft wing surfaces. Each fan is encased in a large duct which engineers predict will add 25 percent to static thrust. Four 1,250-hp T-58

Rising vertically from a wooded clearing, the X-19 rotates its propeller pods to accelerate into forward flight



turboshaft engines, two inboard on each side of the fuselage, are mounted on the rear wing and provide power to the fans through a system of interconnected shafting.

The short, squat (40 ft wide x 36 ft long) X-22 testbed, like the X-19, is designed for a 1,200-lb or six passenger payload. Cruising speed will be about 320 kt.

A unique innovation in control of the aircraft is the use of large flaps which extend down from the ducts during hover and aid in counteracting yaw. As the entire ducted fan system rotates forward 90° to achieve transition, the flaps function as ailerons and elevators.

X-22 prototypes are planned as half-scale testbeds. Two will be built and delivery is forecast for the spring of 1966.

XV-6A (P.1127)

Photographed and ballyhooed as much as any glamorous cinemawench, the British Hawker-Siddeley P.1127 has been cited as being closer to becoming an operational aircraft than any other V/STOL the United States is evaluating.

Since its first transition flight in September 1961 the P.1127 has racked up better than 1,700 landings and takeoffs. It is a tripartite V/STOL venture funded jointly by the United States, Great Britian, and Germany. The Army is the United States' program manager for the project and supplies 50 percent of U.S. funds.

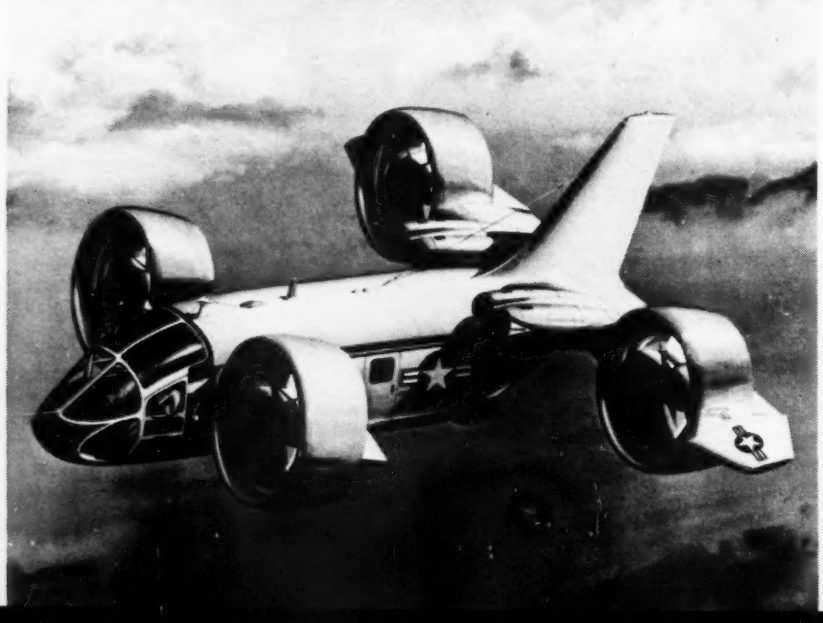
The Hawker-Siddeley design was heralded overseas as a major aircraft development. A supersonic successor, the P.1154, is being considered as an eventual replacement for current NATO strike aircraft.

The world's first V/STOL squadron, to be equipped with nine P.1127s, is now being formed at Norfolk, England, to evaluate operational tactics. A number of pilots from each of the three participating countries have been assigned to the unit. A U. S. Army lieutenant colonel has been assigned as one of the two deputy squadron commanders.

The aircraft is powered by a single Bristol-Siddeley Pegasus BS-53 engine. Effect of this design feature on operational safety is certain to be eyeballed closely during tripartite evaluation.

Large air intakes and swept back wings with 10° of anhedral give the aircraft a businesslike appearance. Its unusual landing gear configuration makes it look like a racer crouched, ready to spring forward. The P.1127 has a single nose wheel and single main strut with two wheels in the center of the fuselage just aft of the center of gravity. Small wheels attached to outriggers on the end of each wing provide lateral stability during landing or takeoff roll. These "grasshopper legs" fold in flight to form wingtips.

Cruise speed of the Navy managed X-22 tri-service V/STOL will be 350 kt. Aircraft is 40 feet wide and 36 feet long.



XV-6A (P. 1127) streaks across the coming its u combination of insignia of three nation aircraf Germany

The Hawker is propelled by blasting thrust from the Pegasus engine through four large, louvered ports, two on each side midway along the fuselage. From a horizontal position these ports vector the thrust by rotating downward 100°. Rotation the last 10° through the vertical (90°) enables the bird to fly backward at a hover. The P.1127 is stabilized during low speed or hovering flight by four jet reaction nozzles which divert high pressure engine air downward. Nozzles in the nose and rear fuselage control pitch, and wingtip nozzles give roll stabilization.

Pilot controls are conventional with the exception of a lever to rotate position of the exhaust ports. Chief test pilot for Hawker cited the aircraft as handling "beautifully."

Designers claim a couple of advantages of vectored thrust over other propulsion systems. They point out that by directing the exhaust horizontally full runup can be performed before vertical flight, a handy feature when operating from an unprepared site with combustible vegetation or loose earth.

Because of fuel and payload considerations, operational V/STOL will use their yo-yo ability only when necessary. Normal employment will be STOL, with a short takeoff roll. Hawker-Siddeley feels their testbed ideally suited for this technique. The louvered ports direct full power rearward; when the aircraft reaches 40 or 50 kt the nozzle selection lever is yanked back to a pre-positioned stop. With this immediate thrust deflection, the aircraft leaps into the air toward a design speed in excess of 600 kt. STOL operation also drastically reduces the problem of ground impingement.

The P.1127 has demonstrated its agility at several international air shows, and was the subject of a nationally televised program in the U. S. It has flown supersonically in conventional flight, sideways at 60 kt and backwards at 25 kt. (One prototype was considerably damaged when it fell in from a high hover at the 1963 Paris Air Show.)

The tripartite V/STOL squadron is expected to begin its evaluation late this year.

XC-142

Heavyweight of American V/STOL projects is the XC-142, an 18½-ton Air Force managed tri-service utility/tactical transport. It is the largest V/STOL ever developed and the first built for operational evaluation. Technical concept of the tilt-wing aircraft was extensively tested by its forerunner, the X-18. First of the five contracted aircraft rolled out of the Ling-Temco-Vought plant in Dallas on 17 June 1964.

Blocky and brawny, the XC-142 will use the muscle of four 2,850 hp General Electric T-64 turboprop engines to tote 32 fully equipped troops or 8,000 lbs of cargo. Its squared-off appearance is seemingly contrary to a design capability of transporting men and supplies around the battlefield at a swift 250 kt.

Development of the aircraft was a coordinated effort with Ling-Temco-Vought as prime contractor and Ryan Aeronautical with Hiller Aircraft as principal subcontractors.

To achieve vertical flight the four engines, mounted on a massive wing, point straight up and the aircraft rises, hanging on the 15.6 ft lightweight fiberglass propellers. As the wing tilts forward during transition to forward flight, large flaps deflect the slipstream to give added lift and improve wing-stall charac-

s the co[illegible]g its unique wing markings, a
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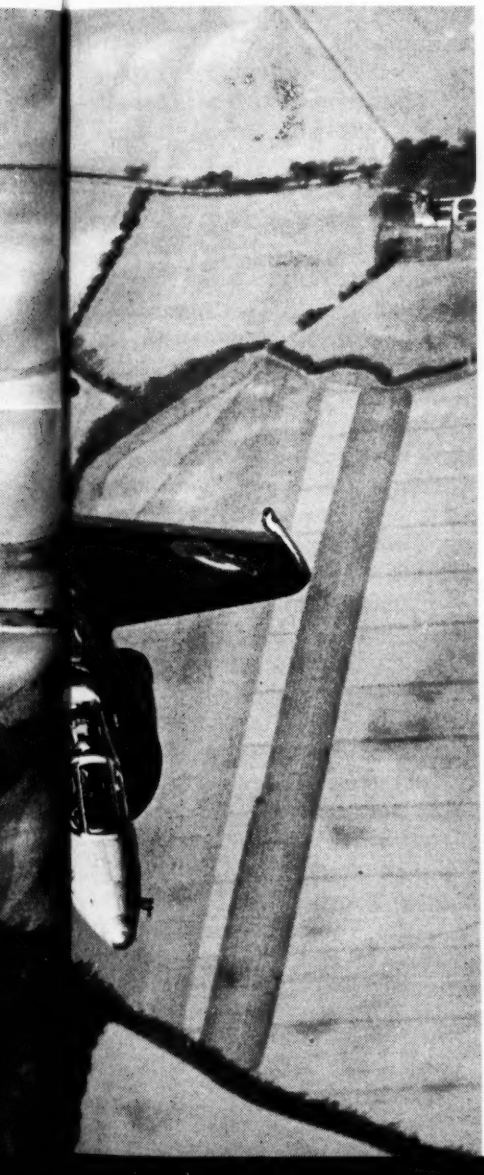
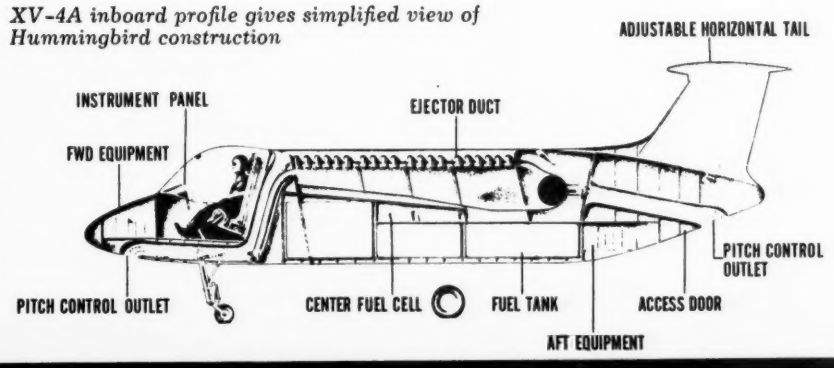


XV-4A inboard profile gives simplified view of Hummingbird construction



Heavyweight XC-142, shown here making its debut, has a wing area of 534 square feet

teristics. A system of cross-shafting and gearing connects all of the engines to the propellers and the tail rotor. Overrunning clutches divide engine thrust equally to all propellers whether only one or all four engines are operating.

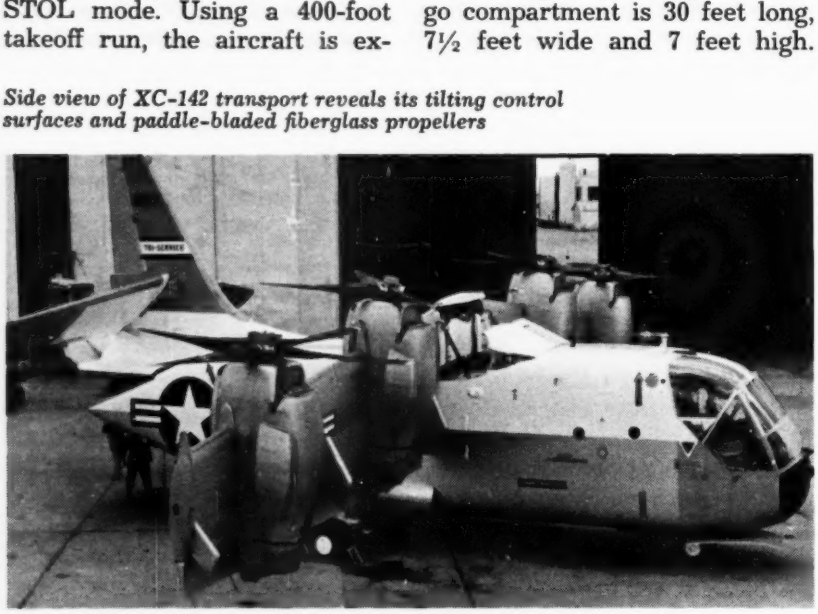
Designers of the vehicle indicate that in conventional flight two of the engines may be kept as "spares" and the remaining two used to power the aircraft. Like most V/STOL designs, performance figures soar in the STOL mode. Using a 400-foot takeoff run, the aircraft is expected to be able to lose an engine and still clear a 50-foot obstacle with a 10,000-lb payload. With all engines, standard day rate of climb at sea level is predicted at 6,800 fpm. On a HOT day, minus one engine, it will still churn upward at a healthy 3,500 fpm.

The aircraft is small in relation to the amount of cargo which can be stuffed inside. It has a 67½-foot wingspan, an overall length of 58 feet and is 26 feet high. The troop and cargo compartment is 30 feet long, 7½ feet wide and 7 feet high. The tail-loading ramp was designed to facilitate transportation of a wide range of military equipments.

The blunt nose and cockpit area contribute to the XC-142's husky look but should give the flight crew excellent visibility. Pilot controls are conventional with the addition of a collective lever which controls prop pitch and engine power simultaneously during V/STOL operations. At a hover, the pilot controls roll by varying prop pitch on either side of the aircraft. Longitudinal attitude is maintained with a variable pitch, 8-foot tail rotor which is disengaged and braked to a halt in a streamlined position during conventional flight. During a hover with the wings pointed up, the ailerons are used to control yaw. During transition yaw is controlled with the rudder.

The control system creates visions of a confused pilot trying to remember which control does what at any particular moment. However, all attitude control inputs are mechanically phased to the appropriate control devices according to wing position. A governor system controls desired engine rpm.

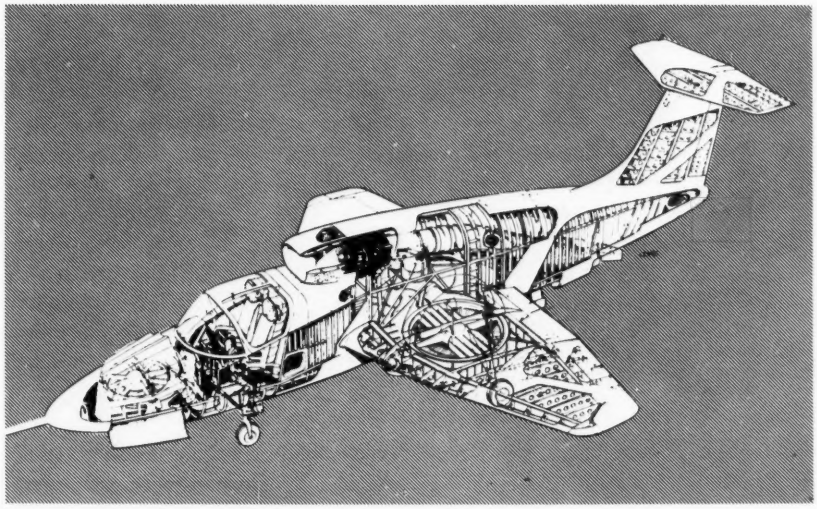
Side view of XC-142 transport reveals its tilting control surfaces and paddle-bladed fiberglass propellers



Hover tests of the XC-142 are scheduled for November and completion of manufacturer test is expected in the spring of 1965. First delivery of the aircraft to the tri-service evaluation team will be in January 1965 with delivery of the fifth XC-142 forecast a little more than a year later.

XV-5A

Two sleek, twin-jet XV-5As have been built by Ryan Aeronautical and General Electric to test the unique "fan-in-wing" concept for possible Army application as a future combat surveillance/target acquisition vehicle.



Detailed plan view of XV-5A. High engine inlets are designed to minimize foreign object and hot gas ingestion

The aircraft is powered by two 2,600-lb thrust GE J85 engines mounted high on the fuselage, aft of the cockpit. Engine jet exhaust drives two 5-foot fans submerged in the wings and a smaller fan in the fuselage nose. Exhaust is carried to the fans through a system of ducts and diverter valves, eliminating the need for conventional shafting and gears for power transmission.

During hover, butterfly-type fan inlet doors in the top of the wings open up and the counter-rotating fans scoop in atmospheric air and direct it down through vertical louvers. For transition these exit louvers are gradually rotated aft, and forward motion increases. At about 120 kt the louvers are fully closed, diverter valves direct thrust out the rear of the aircraft, butterfly doors clang shut and transition is complete. The nose fan is used to control pitch as well as provide lift during hover and transition.

XV-5A designers enthuse over the thrust augmentation achieved by the fans. They claim the lift-fan system will multiply engine thrust by 300 percent, improving fuel consumption and range/payload capabilities. Another design advantage cited is that the main fans operate at the same relatively low rpm as light aircraft propellers, about 2250 rpm.

The fan-in-wing concept is a research development contracted for by TRECOM. In most V/STOL designs which use pure jet thrust for vertical lift, total installed power needed for hovering cannot be efficiently used during cruise flight. Wing fans of the XV-5A are planned to give the aircraft rotor system lift efficiency and allow installation of more economically sized engines for forward flight.

Thrust multiplication achieved by the fans is also expected to give the aircraft eye-opening performance during STOL operation. The two J85s produce 5,316 lbs of thrust as straight turbojets. By vectoring the exit louvers aft, the fan system delivers 8,400 lbs of static thrust, enabling the aircraft to break ground quickly.

The needle-nosed XV-5A testbed, 44.5 feet long with a 30-foot wingspan, is designed for a maximum VTOL useful load of 4,850 lbs (fuel plus payload). Maximum horizontal speed at sea level is 475 kt and top altitude capability is 40,000 feet.

Designers claim that at landing weights below 8,000 lbs the aircraft can land vertically on a single engine; and flying conventionally it will be able to take off and fly at all gross weights on one engine.

During hover and transition all attitude control is provided by the three fans. At about 40 kt aerodynamic control surfaces become effective. Pilot attitude inputs with conventional stick and rudder are automatically directed through a mechanical mixer to fans or conventional control surfaces. The pilot has a "collective" stick to control the aircraft in vertical operations. A twist-grip throttle on this lift stick is mechanically linked to the regular throttles, eliminating the requirement for the pilot to shift hand or foot positions during transition.

When the aircraft screeches to a relative halt from cruise to transition speed the lift fans must reach operating rpm quickly. To reduce fan spin-up time to 1½ seconds, thrust spoilers aft of the exhaust noz-

XV-5A hovers in the California desert during Edwards AFB flight testing

zles allow full engine thrust at lower flight speeds.

Design characteristics of the XV-5A are an extension of vertifan studies begun in 1958 by Ryan and General Electric, firms with an impressive background in V/STOL and powerplant research. Before construction of the two aircraft, a grueling series of scale model aerodynamic tests were conducted in wind tunnels throughout the country. Two full-scale lift fan models were tested in the NASA Ames wind tunnel at Moffet Field, Calif., and wind tunnel evaluation of the XV-5A concept has exceeded 600 hours. Full-scale propulsion system testing has reached 500 hours.

When completed, both aircraft underwent extensive structural, ground resonance, systems and engine tests at Ryan's Lindbergh Field, San Diego. The first XV-5A was shipped to Edwards Air Force Base in January 1964 where test pilots have since been cautiously poking into its flight envelope.

Aircraft no. 2, wrapped in protective shrouds, was hoisted aboard the aircraft carrier *USS Ranger* in March and shipped to the Ames Research Center. It will undergo a series of aerodynamic tests in the Ames' 40′ x 80′ wind tunnel before joining its sister ship in flight testing at Edwards. Army has funded the XV-5A program through 50 hours of flight test. First conventional flight was made at the California desert base on 25 May 64.

A big step towards transition was made 16 July when the aircraft first hovered. Ryan test pilot with the XV-5A has acquired V/STOL experience at the controls of the X-13 Vertijet, VZ-3RY vertiplane, and the flexwing Fleep. In its hover test the XV-5A rose gracefully, sat in the air motionless for a moment and descended to a gentle touchdown.

★ ★ ★

As V/STOL concepts leave the drawing boards, complete static tests and enter flight evaluation they represent the fruition of years of planning and research. But they represent only the beginning of the push towards operational vehicles and future evaluation of aircraft employment.

Some will die on the financial vine. Others may prove technically, tactically or economically unfeasible. Others, it is hoped, will pan out as prototypes of a useful tool to aid the soldier in gaining dominance over the combat environment.

In its quest for mobility to "loose the surly bonds of earth," to break the restraint of terrain on ground movement, the Army is taking a wide-angle look at V/STOL.

Ryan test pilot examines XV-5A. Raised portions of wings are butterfly-type doors which open when aircraft is in vertical mode

Captain R. B. DeFrance

Indications of Leadership

Proficiency

Discipline

Morale

Esprit de Corps

RECENTLY I came across an article in another magazine which seemed well worth reading. Before starting the article, I read the short biographical sketch about the author. It described him in casual and, in my opinion, somewhat flippant terms. Immediately my interest in reading the article dwindled. This told me nothing of the educational or professional capability of the author.

The point is that the biographical sketch was an unprofessional glimpse of a capable officer. This is often the point of view for Army Aviation. How many times have you heard these words: Army Aviators are bred in pinochle games and born at the Officers' Club bar? Such general phrases are thrown around in military ranks by professional officers although Army Aviation, with its growing pains, is proving itself more and more essential.

Capt DeFrance is attending the Command and General Staff College, Fort Leavenworth, Kan.

Army Aviation leaders at all levels should emphasize a professional outlook of military life. Aviators are not exempt from spit-shining shoes. However, many aviators have the general attitude that working closely with aircraft, scuffing shoes while climbing into aircraft, and spilling gas on shoes is an excuse not to shine shoes at all.

The flight clothing an aviator wears differentiates him from his contemporary. While flight clothing serves an important function, its wear should not be abused. Flight jackets have their place as does the flight suit, but this clothing should not be worn everywhere. Why not, if they are an item of issue? For the same reason the fatigue uniform is not worn everywhere. Uniform military dress is a tangible sign of the esprit of the unit. Leaders should establish a firm policy on the wearing of the flight uniform, but this certainly should not be taken to the illogical extreme of prohibiting its use.

Military leadership is as applicable in aviation as it is in any other part of the Army. By setting the example, those associated with Army Aviation can gain the respect which they deserve.

Leadership indicators are *proficiency, esprit de corps, discipline* and *morale.*

Proficiency for the aviator not only includes proficiency in the aircraft he is flying, but proficiency in his basic branch. We are officers first and then aviators, not the reverse. If the officer neglects either his basic branch or his flying, he is substandard.

Esprit de corps is pride in and enthusiasm for a unit by its members. It is loyalty of the aviator for aviation. The individual aviator by adhering to military dress, formality, and custom adds a tangible leaf to the intangible feeling of esprit. The esprit de corps of aviation depends upon the satisfaction of the members. These members are not satisfied when small empires are built and aviation cliques exist. Discipline, proficiency, and a mature attitude of leaders helps build the esprit of a unit.

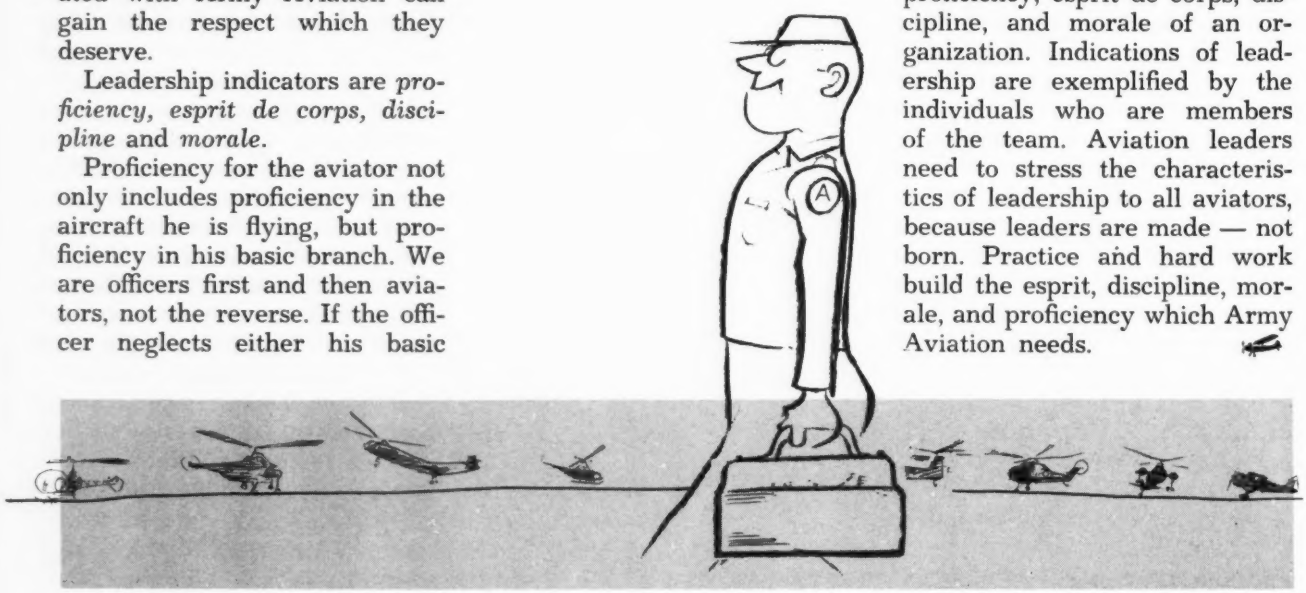
In my opinion, discipline within Army Aviation tends to be lax. This is a natural weakness since "familiarity breeds contempt." In aviation organizations the ratio of enlisted men to officers is more equal. In an airlift platoon of any airmobile company are 10 enlisted men, 6 warrant officers and 3 officers. An infantry rifle platoon has 43 enlisted men and one officer. Aviators and crewchiefs work closely. While flying almost continuously together in the same aircraft the officers and enlisted men tend to forget military etiquette. D i s c i p l i n e must be stressed in such a situation.

Morale is the product of discipline, proficiency, and esprit de corps. It is the individual's state of mind. Personal appearance, conduct, response, and willingness to obey orders are indications of morale. Morale is built in an organization and the foundation is discipline.

All of these indications of l e a d e r s h i p are interrelated. Leadership needs to be emphasized in aviation.

Ask yourself these questions: When was the last briefing you attended where you unbuttoned your blouse for a little more comfort? When was the last time you took your cap off while riding in a car because it was so warm? Or when were you riding in a car with a fellow officer and felt his salute was sufficient for the gate guard and did not bother to return a salute? How many times have you seen these incidents and others similar to them happen?

The little incidents of individual indifference tear down the proficiency, esprit de corps, discipline, and morale of an organization. Indications of leadership are exemplified by the individuals who are members of the team. Aviation leaders need to stress the characteristics of leadership to all aviators, because leaders are made — not born. Practice and hard work build the esprit, discipline, morale, and proficiency which Army Aviation needs.



Are you interested in just flying an Army aircraft? Or do you feel that the more you know about your aircraft, the better chance you'll have to cope with any emergency or malfunction that may occur?

Don't you be guilty of

Pilot Ignorance

Captain Thaman N. Corley

CAPT JOE D. Konley's fingers shook just a little as he quickly tore into the long, white envelope from the Pentagon. For five years he had been an Army Aviator, the last two in the hot, dry wasteland of Fort Eureka. Over 1800 accident-free hours, and still he had no checkout in any of the twin-engine aircraft. Perhaps this would be those long awaited orders for a multiengine checkout. Sure enough, it was orders for the 38th Air Assault Division in Europe with TDY to USAAVNS for the CV-7A transition course.

After several weeks of classes, exams, and checkrides, Captain Konley was rated in the CV-7A. A better than average student, Captain Konley, along with several other students in his class, wrote a course critique sheet stating: "The maintenance instruction is too technical. An aviator doesn't need to get into the nuts and bolts because this is a job for the maintenance personnel."

The gist of the above story is something that takes place quite

frequently when aviators, experienced and not so experienced, are transitioned into the more complex Army aircraft and helicopters. It's not too uncommon to hear the story, "I haven't got time to attend ground school. Can't you sign me off without that?"

As an instructor and section chief in the Department of Maintenance, USAAVNS, I have had the opportunity to monitor several hundred aviators as they have transitioned into various aircraft in the Army inventory. Many conversations and course critique sheets have led me to believe that many of the aviators flying today are interested in just that — flying. To them, maintenance is a separate field from the serious business of flying.

Are Captain Konley and his companions right? Does the Army expect the average Army Aviator to know a lot of unnecessary technical information about the equipment he is flying? Can we, as aviators, afford to kick the tires, light the fires, and blast off, leaving the maintenance problems to the mechanic, crewchief, and maintenance officer?

Granted, it would be much easier if we could read the -10, receive a few hours of flight instruction, and be on our merry way. I cannot believe that any aviator ever feels that he has too much knowledge about his aircraft, its systems and subsystems. Yet, when we say that we are getting too technical, we are saying in effect: This particular item, although it is a piece of mechanical equipment made by man, is so perfect that nothing can ever go wrong with it. Therefore, I have no need to learn anything about this aircraft unless it is directly involved with the flying of the aircraft.

This type of argument, like almost anything else, can be carried to an extreme. I personally feel that the more you know about your aircraft, the better chance you have of coping with any emergency or malfunction that may occur. Consider the following examples that require a decision by the pilot in command. Consider also, that you have to have more than a passing acquaintance with your aircraft to come up with the correct decision.

You are completing a flight in a U-8D Seminole and have just placed the gear selector handle in the down position. The green nose light does not come on and the red light in the selector handle remains on. Do you attempt to recycle the gear, immediately go into emergency extension procedures, or do neither one until you have made a drag past the tower to see if the nose gear is still in the wheel well? Could you remedy the situation by g forces caused by diving the aircraft and pulling up abruptly? Would your decision be influenced either way if this were a test flight following a retraction test?

Your mission is to transport four litter patients in a CV-2B Caribou to an airfield some 100 nm from your home field. Investigation reveals that the field is 2,800 feet long with no barriers on either end. During your preflight inspection you find that the brake accumulator pressure reads 400 psi. Your crewchief tells you that the brake accumulator pressure is not too critical unless you have to make a sudden stop. Maintenance is not available and this is the only method available for transporting the patients, two of whom are on the critical list. Can you make the right decision without knowing exactly how important the brake accumulator pressure is?

You have just made a takeoff in a U-8D Seminole and are pulling the propeller levers back to cruise power. At this time you notice that one of the propeller levers is binding. As you pull it farther to the rear, something evidently breaks because the lever can be moved fore and aft without any effect on the engine rpm. Is this an immediate danger? Should you land immediately or proceed to your destination some 40 minutes away? Could you feather this engine? Could you maintain flight if that engine failed? Is the probable cause in the governor or in the linkage?

You and a copilot are cruising at 9,000 feet in a U-6A Beaver on a clear, cold night approximately 30 minutes out from your home field. The nervous copilot has convinced you that you should switch from the center fuel tank, which has 4 gallons remaining, to the front tank, which is still full. As you reach down to switch to the front tank, the fuel selector handle comes off in your hand. Do you jump or is there some way you can switch tanks?

You are sitting in the runup position in a U-8 or CV-2B waiting for an IFR clearance. This and landing traffic causes you to remain in the runup position for approximately 30 minutes.

Capt Corley was Chief, U-8 Section, F/W Branch, AMD, Dept of Maint, USAAVNS, when he wrote this article.

When you are cleared for takeoff, you immediately pull out on the runway and begin your takeoff roll. As you pass through the point where you should begin to rotate the nose wheel, you notice that your airspeed is too low to begin the rotation. A quick cross-check reveals that manifold pressure and rpm are normal along with the other instruments, with the exception of a slow airspeed on both indicators. What is your most probable cause? Should you continue the takeoff or abort? On a short strip you don't have a lot of time to make a decision.

You are flying a UH-1A at night over mountainous terrain. Since the minimum obstruction clearance is 6,000 feet MSL, you have elected to cruise at 8,000 feet MSL. Your flight progresses normally until the fuel boost pump failure light on the master caution panel pops on. Does this present a particular problem if the engine driven pump is functioning properly? What action, if any, is necessary on your part?

You are flying a routine service mission in a UH-1 with the force trim in the off position. Suddenly, you notice a slight binding in the fore and aft cyclic, as if the force trim were in the on position. All other controls, however, are functioning normally. Would you execute a precautionary landing or complete your mission?

These are a few of the actual situations that have occurred. Unfortunately the -10 and -20 for each aircraft cannot cover every problem that may develop during the life of the aircraft. As you have undoubtedly guessed, most of the above examples fall into this category. However, a thorough search of the appropriate -10 and -20 should furnish enough information to come up with the right decision.

Undoubtedly the increasing complexity of today's aircraft will lead to many other abnormal situations that the aviator will have to cope with. Can we, as Army Aviators, actually say that our maintenance training is too technical just because someone throws a few nuts and bolts at us? How many of us are capable of accurately describing some of the more simple malfunctions to the crewchief or mechanic? The school solution to the questions asked in the above situations is the same as any other solution: know the technical manuals.

How many aircraft accidents wind up with the fault being laid to "pilot error"? More, I think, than many of us would care to admit. *Actually, many of these aircraft accidents caused by "pilot error" may well be caused by "pilot ignorance."*

This term, pilot ignorance, is treading on dangerous ground and can very quickly lead to the loss of tempers between the best of friends. However, many small malfunctions, or emergencies as they are commonly called, lead to major accidents simply because the pilot cannot cope with the situation.

For example, during the first nine months of 1963, major accidents involving the U-8, OV-1, and CV-2B caused by mechanical malfunctions cost the government $5,774,076.85 and the lives of two crew members. Keep in mind that this includes major accidents caused by mechanical failure of only three types of aircraft and does not include the other major accidents, forced landings, incidents, etc. of the same type aircraft or of any other Army aircraft.

Although the above figure involved only 11 aircraft, two of these accidents were caused by pilot ignorance. It is very probable that some of the other accidents also were caused by pilot ignorance, but this could not definitely be established. Undoubtedly a thorough knowledge of the aircraft and all of its systems would substantially reduce the number of accidents in Army Aviation over a period of several years.

An Army Aviator is not expected to be a mechanic, and he would indeed be overpaid if this were the objective of his maintenance training. By the same token it would be more than nice if it were possible for each aviator to make on-the-spot emergency repairs if and when he is faced with the requirement. However, technical knowledge of his aircraft is an absolute necessity for the aviator to analyze the trouble in a specific system, respond correctly to emergency situations that are not possible to cover in the course of normal training, and to meet the multitude of other unexpected events that are continually cropping up.

In all sincerity, can you think of any better way to meet unforeseen mechanical failures and malfunctions than with thorough technical training and knowledge? Surely a thorough technical knowledge of your aircraft will lead to many improvements in Army Aviation as well as a better chance for each of us to enjoy our retirement pay.

An instrument rating is a ticket to trouble unless its use is tempered with common sense

IT COULD HAPPEN TO YOU

Lieutenant Colonel Barrie S. Davis

A GOOD BREEZE was blowing across Zebulon's dirt strip as I waited for Maj Bill Griffin and Capt Jack Schultz to pick me up. I watched the U-6A rock and toss as Bill expertly brought it in, right wing low to compensate for the stiff crosswind. A high overcast hid the early afternoon sun as I gave my wife a goodbye peck and climbed aboard the Beaver for the first leg of a planned flight to Fort Leavenworth, Kan.

I settled down in one of the rear seats, fastened my seat belt, and Bill poured on the coal. The faithful old Beaver quickly lifted off the sod and Bill pointed its nose westward, while Jack tuned in RDU omni. To while the time away, I pulled charts from my Jeppesen case and casually checked the course.

"You filing IFR?" I asked over the intercom.

"Negative," Bill replied. "The winds are strong against us at the higher altitudes, so we decided to try it VFR across the mountains. ATC won't clear us over the Smokies lower than 8,000."

The winds were not kind at 3,000, cutting the Beaver's groundspeed to 60 knots. A little mental arithmetic indicated we'd have to set down for fuel well before our first planned stop at Evansville, Ill.

Raleigh-Durham, Greensboro, and Winstom-Salem passed below. Slowly but surely we winged westward. The Piedmont plain became foothills to the Smokies. The hills grew higher and clouds came lower until the peaks of the mountains disappeared into a grey mist.

We dropped down across the ridges as the last rays of light shone through breaks in the clouds. Cars winding through the hills already had their lights on, and spotted in the valleys we could see lights along village streets begin to burn.

Turbulence grew worse as daylight waned. Bags bounced around the cabin while we skimmed over the ridges. Twilight dimmed our last hope that the clouds would lift. So, as my Jeppesen case took a crazy bounce and landed in my lap, we all agreed to return to Hickory, land, refuel, and refile for an IFR trip across the hills.

Hickory's VOR came in strong as we sped out of the hills, helped by a stiff tailwind. The runway lights were visible from 10 miles out, and the gentlemen in Hickory Flight Service Station advised us of surface wind and active runway.

Climbing out of the Beaver after parking at the gas pump, we announced proudly: "Discretion is the better part of valor." Actually no discretion was involved. The mountains just were not to be crossed VFR in darkness — not that evening, anyhow.

Inside the Hickory fixed base office, we found the assistant aviation officer for our National Guard unit filing with FAA for a VFR trip in an O-1 Bird Dog. Overhearing our plan to fly IFR directly from Hickory over the mountains to Holston Mountain VOR, he warned: "Don't let them send you over the mountains too low. When the wind's blowing like it is tonight, you can get some mighty mean waves, especially around Grandfather Mountain."

"No sweat," we assured him. "We're asking for 9,000. We've had enough of wind at the ridgetops."

Hickory has no tower, and Flight Service Station asked that we give them a call after takeoff and then circle Hickory until

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Col Davis is Commander, 30th Avn Bn, North Carolina Army National Guard, Raleigh-Durham Airport, N. C.

our clearance came through. This we did, and FSS came in quickly: "ATC clears Army Guard 60375 to Evansville airport via Collett intersection, Victor 259, Holston Mountain, flight plan route. Climb to and maintain 9,000."

We turned westward, watching the lights of Hickory fade slowly — so slowly — behind. At 5,000 feet indicated, Hickory turned us over to Atlanta Center. We relaxed and let the venerable old Beaver work at the task of getting us through the broken clouds to 9,000.

Atlanta Center interrupted our reverie with a change in clearance, sending us upward to 11,000 feet. "How about compromising at 10,000?" we asked. "This old bird might not be able to get to eleven."

But other traffic had 10,000 feet tied up, and we continued to inch upward, throttle to the firewall and manifold pressure controlled by the rpm. Eventually we reported level at 11,000, adjusted power, and commented on the contrast of the night's smooth air compared with the afternoon's turbulence.

Then the Beaver began to sink, losing altitude at an increasing rate. The nose was brought up to climb attitude, the power was increased — slowly — then all the way forward. Still the Beaver dropped. Climb flaps were extended, and when the altitude indicated 7,400 with no indication of the descent slackening, Bill told Atlanta Center we were changing course. He made a 180 and headed back from whence we had come.

Atlanta Center discussed our situation with us and cleared us for another try, this time at 8,000 feet. Another 180° turn and we headed back up Victor 259, level at 8,000. This time the loss of altitude was not expected, but the high rate of descent was. The air was perfectly smooth, but with everything pushed to the stops and climb flaps down, the Beaver dropped to 5,400 feet before we could reverse course and move out of the wave. The thought of 6,000-foot peaks hidden in the clouds provided no feeling of security.

Atlanta Center was informative and cooperative when we reported our latest change of altitude and heading.

"Did you encounter ice?" Center asked.

"Negative. The wind blew us down."

"Thought you were having trouble," Center came back. "You haven't moved on our scope for 15 minutes!" Then Center added, "An Air Force transport coming down Victor 259 from Holston Mountain reported tailwinds of more than 80 knots!"

That's when we executed a plan which should have been placed in effect long before. Center accepted a change in course to intercept Victor 222 to Asheville, thence to Knoxville, and on to Crossville, Tenn., where we refueled.

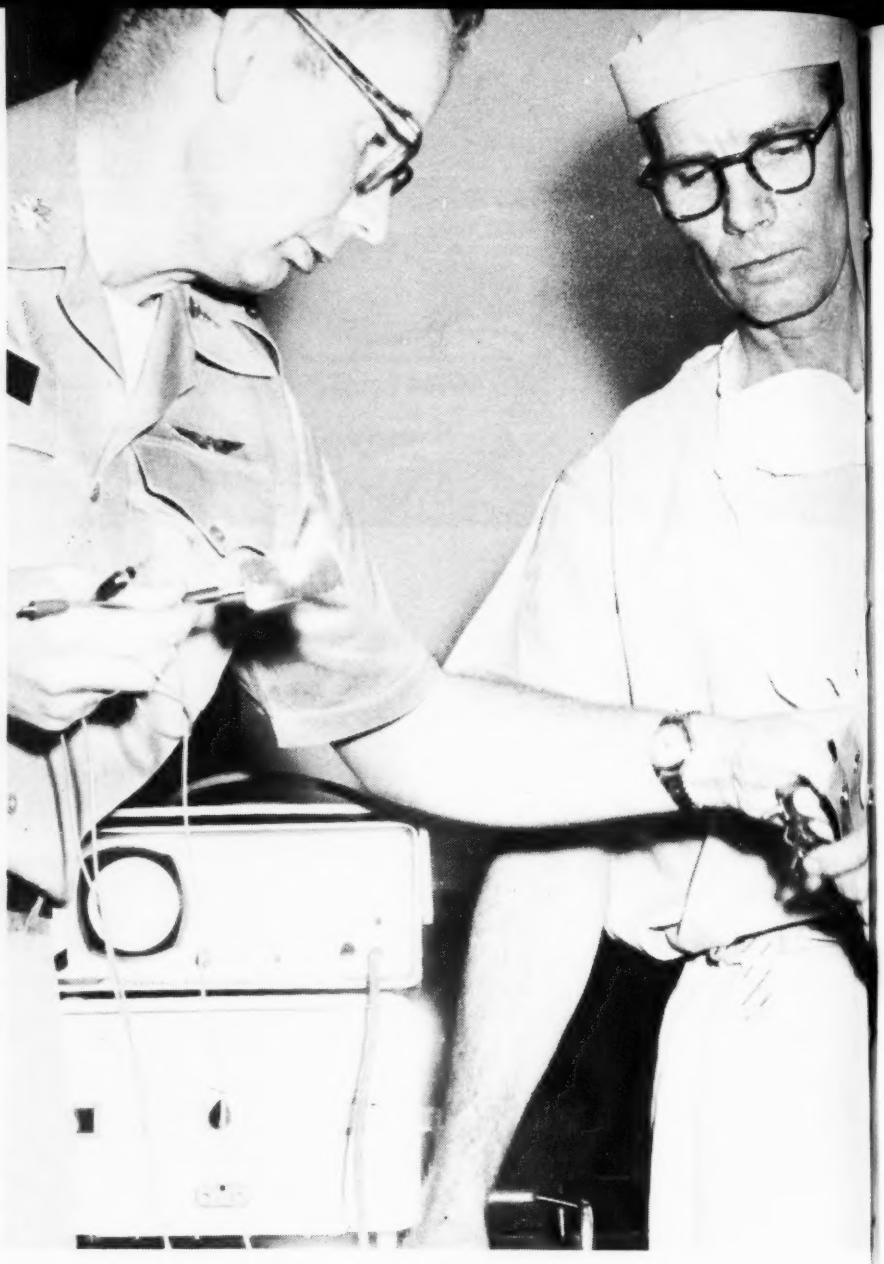
I'm certain the gentleman in Atlanta Center was delighted when, shortly before midnight, Army Guard 60375 was handed off to Indianapolis Center and became its slow-moving headache.

We learned a lot on the trip. An instrument rating is a ticket to trouble unless its use is tempered with common sense.

Mountain flying can play unexpected — and sometimes fatal — tricks on unwary airmen. And, happily for us, all the FAA people were, as usual, filled with patience, understanding, and a genuine desire to be helpful to an ancient, noisy Beaver loaded with three Army Guardsmen.

Major James E. Hertzog

new aeromedical education and training department added to USAAVNS



A cardiac defibrillator is demonstrated

THE CURRENT expansion of the overall Army Aviation program has necessitated a concurrent expansion in the Army Aviation medicine training program. To implement this expanded training program, a Department of Aeromedical Education and Training has been established within the U. S. Army Aviation School, Fort Rucker, Ala.

The department director will be responsible for all matters pertaining to aeromedical education and training. He will supervise, coordinate, and conduct all aeromedical education and training activities within the school. The department will also

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Maj Hertzog is Director, Department of Aeromedical Education and Training, USAAVNS.

provide support to the clinical aviation medicine and aeromedical research and development activities which now exist at the U. S. Army Aviation Center.

The newly-established department of the U. S. Army Aviation School will function jointly with the U. S. Army Hospital in providing the professional and technical medical faculty for the Army Aviation medicine training program at the U. S. Army Aviation Center.

Other organizations contributing to the overall aviation medicine training programs are the U. S. Army Aeromedical Research Unit, the U. S. Army Board for Avn Accident Research, the U. S. Army Avn Test Bd, and the U. S. Army Combat Developments Cmd Avn Agency. Students attending the training programs will be attached to the Officer Student Detachment, USAAVNS.

Concurrently, the following Aviation Medicine Courses are being conducted:

Basic Army Aviation Medicine Course (BAMC) — CONARC designated 1-A-3160, this 4-week course awards the graduate a D-3160 MOS. It provides Medical Corps officers with a working knowledge of the principles and practices of aviation medicine and their application to the medical support of the Army Aviation mission. Academic and applicatory aviation medicine constitute 101 hours of the course. The remaining 47 hours are devoted to general Army Aviation subjects and flying familiarization. This program is designed for junior, short-term medical officers who will practice aviation medicine at unit level under supervision.

Army Aviation Medical Officer's Orientation Course (AAMOOC) — This CONARC designated course 1-A-F8 lasts 3 weeks and produces no MOS change. It provides Army graduates of either the USAF or USN Schools of Aviation Medicine with training in the unique aspects of Army Aviation medicine, the Army Aviation program, and the application of the basic formal instruction previously received. Sixteen hours of this course are used for academic and applicatory aviation medicine. The remaining 93 hours are devoted to general Army Aviation orientation and flying familiarization. This program is designed primarily for career and/or field-grade medical officers who will support the overall Army Aviation medicine program in clinical consultation, education and training, and research and development capacities.

Advanced Aviation Medicine Residency Program — The U. S. Army Hospital is approved by the American Board of Preventive Medicine and the American Medical Association, as an affiliated training site of the USAF School of Aerospace Medicine, to conduct the third year of formal residency training (applicatory Phase III) leading to certification in Aviation Medicine. This program lasts 12 months and consists of rotation through positions of responsibility in aviation medicine, preventive medicine, and aeromedical education and research under the immediate supervision of a designated preceptor who is certified as a specialist in aviation medicine. Graduates of any of the approved basic courses (USA, USAF, USN) are eligible for this advanced training.

Student Aviator Instruction Program — Students attending the flying training programs of USAAVNS are given periodic instruction on the problems which exist within the aviation environment that represent potential hazards to aviation health and safety. Approximately 40 hours of instruction per month are given in this area.

Student flight surgeons receive practical instruction in techniques of examination and treatment of the nose and throat.

With the establishment of the Department of Aeromedical Education and Training, the following formal training programs are being considered for implementation:

Medical Service Corps Aviator Medical Qualification Course — This course will be of approximately 3 weeks duration. It is designed to provide Medical Service Corps aviators with intensive training in critical areas, such as resuscitation, emergency medical care, management of shock and trauma, patient selection for aeromedical evacuation, and inflight patient care procedure.

Army Aeromedical Specialist Course — This course will last approximately 4 weeks. It is designed to train the aeromedical specialist to assist the flight surgeon in aeromedical administration, aviation physical exams, aeromedical evacuation, and personal aeromedical equipment.

An Army Flight Nurse Orientation Course and *an Army Aviation Accident Investigation Course* are under consideration.

Adjusting turnbuckles need not be a problem if you happen to have three hands and work very carefully. Perhaps the simple tool described here can give you that third hand and help eliminate from flight control assemblies this

Weak Link

Lieutenant Larry R. Martin

HOW MANY PILOTS have had fear about their aircraft holding together in turbulent air? How many mechanics have had doubts as to the quality of a job done on the rigging of flight controls?

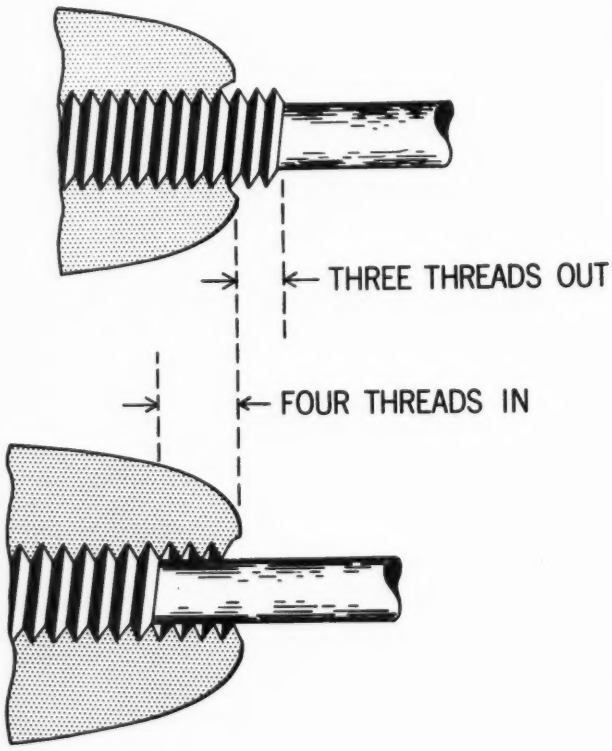
A check of the accident record of flight control failures compiled by the Analysis-Research Division of the U. S. Army Board for Aviation Accident Research reveals that from 1 July 1957 to 30 September 1963 there have been 16 fixed wing accidents caused by flight control failures. These included 5 major accidents, 4 incidents, and 7 forced landings.

Rotary wing flight control failures during the same dates accounted for 82 accidents. A further breakdown shows that four accidents on record were due to control linkage failures. Out of these accidents come some interesting stories.

"Bird Dog on the loose" would be a good expression to describe the events that took place during a summer evening flight in an O-1. The pilot, Lieutenant Shook, was on a tactical problem, flying his aircraft to the release point for ammunition resupply to a patrol caught behind aggressor lines.

Lt Martin is assigned to the F/W Branch, AMD, Dept of Maint, USAAVNS.

Figure 1. Total tolerance — 7 threads each



The weather report he received included light rain showers in the area. While enroute he encountered what he believed to be a rainshower. He had to be at the RP within 3 minutes of his ETA or he would not be cleared on the drop zone. This meant that to be on time he would have to fly through the seemingly light rainshower.

Since he figured he could maintain VFR conditions, he proceeded through it; and when he was just about through he encountered some moderate turbulence. Normally this would have been no problem, but . . . the strain on the control surfaces sought out a poorly rigged turnbuckle in the carry-thru cable for the ailerons. The turnbuckle gave way, making the ailerons useless, and another accident appeared in the files.

A forced landing can usually be made if some other system fails, but a loss of control presents a real problem.

In the makeup of the flight control assemblies, there is potentially a weak link: the turnbuckle. TM 55-405-2, para 71, gives directions for the installation of turnbuckles. "a. When installing cable system turnbuckles, screw both threaded terminals into the barrel an equal distance. All terminals must be screwed into the barrel far enough that no more than three threads are exposed." These limits are shown in figure 1.

Adjusting the turnbuckles need not be a problem if you happen to have three hands and work very carefully. The unevenness of the turnbuckle assembly will usually occur on turnbuckles with cables on both ends.

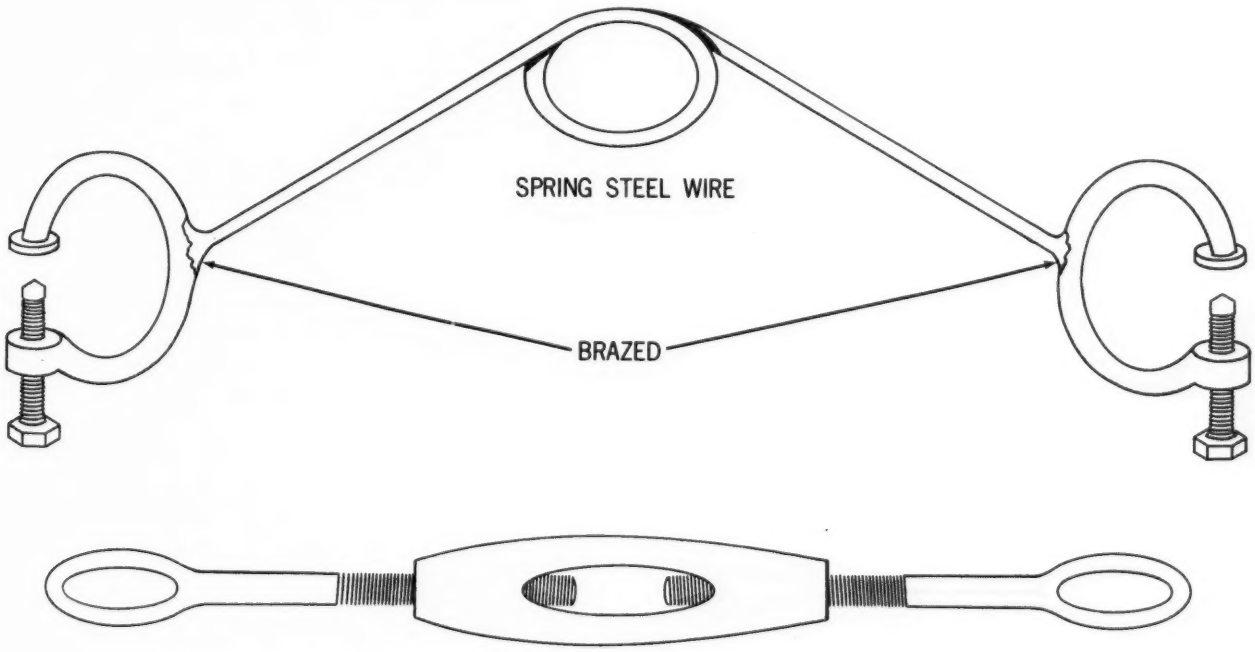
To ensure that the cables do not turn during adjustment and even adjustment is made on the turnbuckle, a device of some sort is needed to hold both cables neutral (no twisting of cables) during adjustment.

This problem can be solved by using a simple tool (fig. 2). This is not a new tool to the mechanic. Various designs of this tool have been made by mechanics who work on all types of aircraft. But apparently it is without patent and appears to be a "homemade" field expedient.

It consists of two small C clamps used to hold each cable end while adjustments are made on the barrel of the turnbuckle. A loop of wire is attached to each C clamp to ensure one end of the cable will not turn independently of the other (see fig. 1). When this tool is employed, a mechanic can be sure that if the turnbuckle had an equal number of threads in each end of the barrel before adjustment, he will also have an equal number of threads after proper tension is attained.

The use of this tool could possibly save money by preventing accidents due to control system failure, save the mechanic's time in rigging aircraft, and could save someone's life.

Figure 2. The utility of this tool is limited only by the length of the steel spring wire connecting the C clamps



Captain William J. Ryan

Quite often, in normal conversation with Army Aviation personnel who are discussing the present state of world unrest, you hear the subject evasion and escape mentioned. Most people agree that training in these areas is a pretty good idea. Questions such as these are asked: Who should undergo the training? Why should I receive this training? What type of training should it be?

Evasion and Escape Training--

Who Neds

IN ONLY ONE of seven major wars have significant numbers of American POWs failed to help one another as much as possible, failed to unite in resisting their capture, collaborated with the enemy, and informed on and mistreated their fellow prisoners, even causing their deaths. In only one war have a disproportionate number of Americans failed to escape from permanent prison camps and return to our lines. This one exception was the Korean War.

During the Korean War, over 12,000 American families received letters stating that a loved one was missing in action.

After the war, 2,700 families were notified the individual had died in a communist POW compound. An additional 3,700 families were notified that no trace could be found of the missing individual and that he was presumed dead.

Of those missing in action in Korea, 1,300 returned to their units, nothing is known of 3,700, and 7,000 are known to have reached prison camps alive (of which almost 3,000 died).

Thirty-eight percent of the Americans who reached prison camps alive died there. This is the highest casualty rate among American POWs in the history of our country.

Before the Korean War, it was presumed that the duties and obligations of our fighting men were adequately covered in training. However, it has been found that the two principle reasons why men become POWs when it could have been prevented were lack of leadership and lack of knowledge.

Of the men captured, 85 percent were in groups of two or more, 70 percent had enough ammunition, and 90 percent had adequate food to continue to resist.

The missing ingredient was someone with the determination and leadership to take command. In some instances, someone did take charge but lacked the

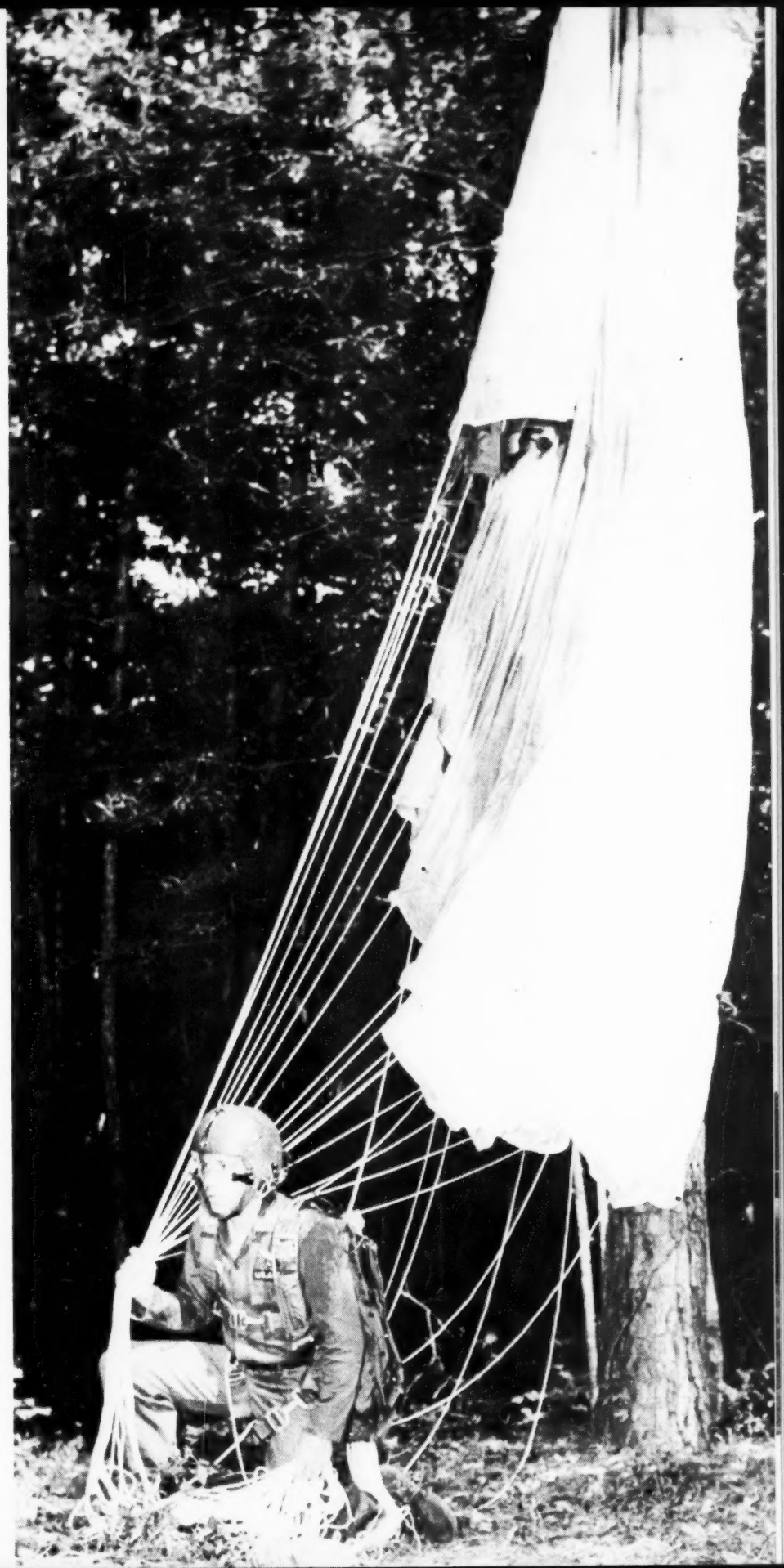
Neds It?

knowledge to take a proper course of action to avoid capture.

Who Should Undergo E&E Training?

The U. S. Army is organized to fight for and protect the United States and its ideals. If the slightest chance exists that the United States and its ideals will be challenged and if an individual wears the uniform of the United States Army, then it is quite obvious that that individual should receive evasion and escape training.

Capt Ryan is assigned to the R/W Suppressive Fire Branch, Dept of Tactics, USAAVNS.



If I am captured I will continue to resist . . .
I will make every effort to escape . . .
I will accept neither parole . . .

Why Should You Undergo The Training?

First of all, AR 350-225 states that you will be trained in evasion and escape. However, ARs sometimes do not inspire motivation, and the letter of the regulation can be complied with quite simply by a dull lecturer reading from an outdated lesson plan.

Ask some veterans if they had time to learn the intricacies of evasion and escape when Korea was attacked, or when they were alerted for immediate shipment to Vietnam, or alerted for the Cuban crisis. You will find that in most cases, these people did go or would have gone into combat relying on the previous training which may or may not have been adequate.

You must agree that past history strongly indicates the need for E and E training.

What Type Of Training Program Should It Be?

IF I AM CAPTURED I WILL CONTINUE TO RESIST BY ALL MEANS AVAILABLE. I WILL MAKE EVERY EFFORT TO ESCAPE AND TO AID OTHERS TO ESCAPE. I WILL ACCEPT NEITHER PAROLE NOR SPECIAL FAVORS FROM THE ENEMY.

We all recognize these words as part of the Code of Conduct of the American soldier, which was generated by the events of the Korean War.

The basic motive for successful resistance (the will to continue) seems to be lacking in a number of soldiers. This quality, whether it is called *will to continue, purpose in life, belief in country, or patriotism,* is an immeasurable thing that should be a part of every American and should be developed throughout life, beginning with the family and continuing through school and community. It is the responsibility of every American from the parent to the President.

It should not be necessary to explain to the young soldier why he must fight and why he must continue to fight under adverse conditions. Yet, since this quality has not been developed, it becomes the responsibility of the Army's training program. Therefore, you must begin with a review of the basic ideals of democracy, its theory, and practice.

The unit character guidance program can be used to great advantage to strengthen the moral fiber and religious motivation of the men and give them a personal code of conduct.

When a man understands the need for evasion and escape and has been prepared mentally and spiritually, he will be more receptive to training. He will perform in the manner expected if he actually is placed in a situation where the use of the training becomes a necessity.

Once the groundwork is laid for the program, it should be tailored to the size and type unit involved. But whether it's a 24-hour program or a 7-day program, it must have some essential ingredients.

The objectives must be thoroughly stated, taught, and tested. The ARs quite amply cover the material that should be included in classroom or practical exercises. The most important portion of the program is the final test, which must be a field problem type exercise.

The students must be placed in situations that require evasion and escape techniques. This can be as a result of downed aircraft behind enemy lines, patroling action, units being overrun and cut off, or any other hypothetical situation that fits the particular unit.

The students must then be motivated to evade and escape. This can only be done by using a proportionate number of well-trained aggressor troops to pursue and hunt the students. They must know beforehand that the reward for capture will be a well run POW compound.

The compound should not only detain those captured, but should tax them both physically and mentally. It has been proved that this can be accomplished without actually endangering the health of the prisoners.

Evasion and escape is a necessary part of any unit's training program, and the only way to make it effective is to make it realistic. Army Aviators are certainly not exempt from this requirement. On nearly every support mission where Army Aviation serves our Allies, the possibility of being forced down over enemy territory exists. The Army Aviator's life can depend on the thoroughness of his evasion and escape training.

HAWK STAR

William H. Smith

"THAT'S IT!" This was our signal to scramble into our seats. The rotors whirled faster into a crescendo of sound, and we were off on what was to be the roughest helicopter ride I have ever taken.

I had been invited to ride in a "gun ship" on a small operation during HAWK STAR I. Our job was to go into an area occupied by an aggressor headquarters to pinpoint the enemy and mark the landing site for troops coming in other helicopters. While they were raiding the aggressors, we were to cover them.

When we reached the area, it took only a second or two to locate the enemy. Near the largest aggressor tents was a small clearing that would do as a drop zone for the troops. We radioed the transport helicopters to come in. Then while waiting we scouted the area for enemy troop concentrations and any other thing big enough to cause trouble.

As the troop-carrying helicopters approached, we headed back to the clearing and marked the spot with smoke bombs. While the troops landed we kept the enemy pinned down by making pass after pass, firing our rockets and machineguns as we went. As soon as our troops cleared, the transport helicopters took off.

At the precise moment our men reached the wooded area, we lifted our fire and moved further afield, to hover protectively over the troop carriers.

Upon sighting an aggressor target, the helicopter would sweep down at it at about 90 knots, firing as it came, and pulling up just in time to clear the trees and other obstructions. While the pilot and copilot were maneuvering the aircraft, the other crew members spent their time looking for dispersed aggressors and, if possible, firing on them with their hand-held weapons. (I spent my time holding on and praying.)

When our troops had finished their raid, the transport helicopters picked them up and we covered again. Then all of us headed home, having completed our mission. Despite the rough ride, I shared with the men a satisfied feeling of accomplishment.

This small operation typified the rip-roaring action of HAWK STAR I, a maneuver held in June at Fort Jackson, S. C., to exercise a brigade-size force of the 11th Air Assault Division.

More than 9,000 men and 275 aircraft participated in the training problem, largest staged by the division since its activation on 15 February 63.

Sky soldiers of the 11th Air Assault Division move out in the assault after unloading from UH-1 helicopters

The maneuver pitted elements of the 11th against "aggressor" units of the 2d Infantry Division. A fast-paced exercise designed to give a further workout to the airmobile concept, the mock battle ranged over a 1.5 million acre, four-county area of South Carolina.

HAWK STAR I also had a "nuts and bolts" objective — to evaluate equipment adapted to enhance the division's mobility.

Back when the division was formed it was realized that much of the equipment used by regular units was too heavy and too bulky and therefore not practical for the air assault concept. Light air-transportable equipment was needed. All those assigned to the division were asked to make suggestions for improving airmobility, and a special idea center to receive and process these suggestions was set up. Personnel were urged to consider the latest equipment developments and study new ways of doing things using these developments. Old taboos were to be thrown out. The result is an outfit that uses a mixture of old and new equipment, some strictly military and some off-the-shelf civilian type.

WATER

As an example, one problem was the supplying of water. Water is a heavy commodity and enormous amounts are used by troops in the field. Many skeptics thought that a division that used aircraft instead of trucks was not capable of carrying enough water.

One obvious answer to increasing the amount of water was to decrease the weight of the containers. Aluminum jerry cans could be used, but lighter plastic containers were even better.

Thus, it was only a matter of finding a suitable plastic container. A commercial product called "Lug-a-Jug" was found to be satisfactory. It held 5 gallons of water, was very light, and collapsed flat when empty. After use it could be thrown away, if necessary, or brought back and reused.

In HAWK STAR I jugs of water were loaded on every aircraft that landed near the division water point. Plenty of water was available for the troops, and some troop-carrying aircraft even made drinking water available to their passengers.

"Lug-a-Jugs" proved useful in other ways. It was discovered that, unlike many plastic containers, they could be used for carrying gasoline and other petroleum products. During the exercise fuel containers were piled under trees handy to jeeps and other vehicles.

FUEL

Another major problem was supplying fuel to aircraft. Earlier, the Army had experimented with round 500-gallon rubber tanks. These proved to be the answer to the problem. They can be carried inside the aircraft, or sling loaded under helicopters. Their resiliency made them ideal for parachute extractions from fixed wing aircraft. Being round, the fuel tanks can be rolled very easily by hand or, by hooking a V cable to the center axle, can be pulled by a jeep.

Rubber tanks also solved the

Plastic jugs used for shipment of water

Rubber tanks used for transport of fuel, easily manhandled by troops or pulled by jeeps

problem of fuel supply for long distance helicopter flights.

In HAWK STAR I "Cows," CH-47s, loaded with three 500-gallon tanks and fuel transfer equipment, sometimes went along on combat missions with troop-carrying helicopters. When the troops landed to attack an aggressor the helicopters retired to a convenient clearing, temporarily free of the enemy, and refueled.

The petroleum, oil, lubrication (POL) dispersing station for HAWK STAR I was located at Hilton Field, Fort Jackson, S. C., about 35 miles away from the main action. Fuel for the station was supplied by 5,000-gallon tankers that came from Charleston, S. C. They used special pumps that operate at a rate of 350 gallons of fuel per minute.

Fuel was stored in twelve 10,000-gallon rubber tanks and 132 500-gallon tanks. A special feature of the exercise was the testing of a 20,000-gallon rubber tank.

Four pumps, each equipped with a water separator, were used for the operation. Water contamination is always a problem in a field exercise. Besides the trouble the water itself can cause, microorganism contamination can occur only in the presence of water.

Individual aircraft among the Hueys of the fast-moving air assault units sling-loaded 500-gallon tanks, which were then located at selected forward positions for refueling during tactical play. Empty tanks were later retrieved by brigade Chinooks for refilling.

CAMOUFLAGE

All aircraft are helpless while on the ground. This is a basic fact that the 11th Air Assault has learned to live with. For this reason the division considers camouflage very important. While operating in the field, every effort is made to hide the aircraft.

There must be cover adjacent to all fields used. A good airstrip for fixed wing aircraft is a straight strip of gravel or paved road with large trees on the side to hide the parked aircraft.

A rough, very woodsy area is preferred for rotary-winged aircraft. Helipads used in HAWK STAR I were so hard to spot from the air that some aviators considered this a problem.

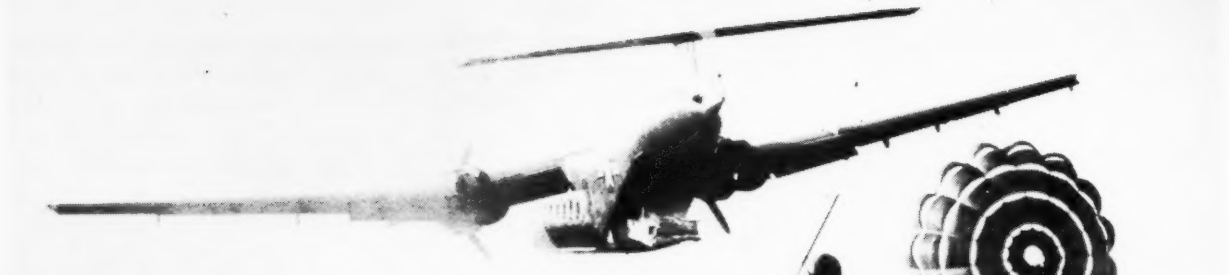
Talking about camouflage, one aviator said, "I was coming in at dusk late one day. The area was full of small bushes, so as an added precaution I took one more look. To my surprise there was another bird just where I was going to settle down. It was so well hidden under its camouflage I could hardly see it."

The 11th Air Assault Division places maximum emphasis on the use of natural foliage and shadows. Aircraft are hidden under trees, large culverts, barns, anything suitable, and skid wheels are kept handy to move them with. When it's not possible to use natural shadows for concealment, the aircraft are oriented with the sun to reduce shadow to a minimum.

Highly reflective surfaces, such as plexiglass and rotors, are covered. In the interest of weight conservation, light synthetic fiber cloth is used.

Fancy paints and other atten-

Huge, rubberized pillow tanks function as storage units at an air assault refueling point



CV-2 Caribou, using low-level extraction technique, unloads ammunition on a wooden pallet to be used by sky soldiers of the 11th Air Assault Division

tion-getting gimmicks are eliminated from aircraft. This includes bright colored lettering and insignia as well as glossy, olive drab paint.

The entire aircraft is repainted with lusterless olive drab, shade no. ANA613 or some similar paint. Some are painted a solid shade, while others are painted in different shades of a bold pattern effect.

On the sides of each aircraft the words UNITED STATES ARMY are painted in lusterless black, shade no. 37038. The star insignia is not used.

NAVIGATION

Flying in the assault division is a "cabbage-patch-to-cabbage-patch" operation. The ability to operate at night and to maximum extent under all weather conditions is a primary requirement. If the aviators fail to find the right cabbage patch, the whole operation falls flat.

In exercise HAWK STAR I the Decca navigation system was used with good results. This system is used quite extensively in Europe by commercial airlines. It is based on the phase comparison of continuous transmissions from three or four stations operating at a frequency around 100 kilocycles. Usually slave stations are set up in a three-pointed star formation around the master station at distances of 70 to 100 miles, but neither symmetry nor distance is critical.

Transmissions from these stations bear a simple harmonic frequency relationship, and those from each slave station are phase locked to the master transmission. By this means, overlapping phase patterns which form a navigational grid in space are produced between the master and each slave.

The aircraft is equipped to receive these radio signals, compute its own position on the grid and present the position information to the aviator in a readable form.

In HAWK STAR I the master station was located at Fort Gordon, Ga., and three slave stations were located at St. George, S. C., Hartwell, Ga., and Dublin, Ga.

An OV-1 Mohawk pilot said, "The Decca system works fine except when your map is in error. Then if you are not careful, you'll figure you're a couple hundred yards over from where you really are."

MAINTENANCE

Repair of aircraft in the field did not cause as much trouble as originally expected. Test of the 11th Air Assault's capability along this line was one of the objectives of HAWK STAR I.

It was found that mechanics assigned to the unit are well able to make most of the repairs necessary to keep the aircraft flying. By using air transportable equipment, including light cranes able to lift heavy parts, unit mechanics are able to do extensive maintenance right in the field.

Average availability of all aircraft was about 87 percent. At one point Chinook availability went as low as 37 percent. The Chinook is still going through advanced user test and is not completely ready for the field. Among the difficulties experienced were those associated with the stabilization augmentation system.

MEDICAL

Even medical equipment received the airmobility treatment. Heavy equipment has been replaced by lighter material. Ambulances have been replaced by the M274 Willys Motors' Mechanical Mule (MULE) carrying four stretchers. Special light sterilizers have been developed and small, efficient refrigerators were purchased for the storage of whole blood, serums, etc.

BIVOUAC EQUIPMENT

In one case the solution to a problem had been around for a long time. A speedy method was needed to load and unload bivouac equipment. During HAWK STAR I some rapidly deployed units found themselves bivouaced in a different area every day.

The Heavy Lift Assault Support Battalion found that those little hand carts used at railroad stations for baggage were just the thing to cart their stuff on. Fitted with rubber tires and a coupling device like those used by railroads, a jeep could pull two of them on and off a Chinook with little trouble.

AERIAL PHOTOGRAPHS

HAWK STAR I was marked by swift, unrelenting pursuit of the aggressor. When the elusive enemy was located he was attacked by hard-hitting reaction forces. His location and defenses were pinpointed by aerial photographs.

To augment the Mohawk surveillance equipment and to provide photo intelligence which kept pace with the rapid action, the division turned to off-the-shelf equipment.

A new hand-held 360° fixed focus camera (the Fairchild 505) was used. It used the Polaroid method or conventional roll film. The Polaroid method takes only 10 seconds to produce a usable positive and negative. The negative can be used to make enlargements. These enlargements are developed and fixed in the same tray and need no washing. The roll film is developed by squeezing the film against monobath saturated sponge rubber.

ENGINEERING EQUIPMENT

Heavy earth-moving equipment for hasty construction of airfields and landing strips was a real problem. It was just not possible to find standard equipment light enough and still able to do a good job against stumps, rocks, and mounds of earth. Air Assault engineers turned to the BEST equipment. Experimental "ballastable earthmoving sectionalized tractors" (BEST) undergoing Army evaluation was procured.

The BEST tractor comes in two sections (front and rear).

Division artillery gun crew manhandles a new XM-102 Howitzer out of CH-47 Chinook helicopter which delivered it to a forward area firing position

The 6,300-pound front section contains powered wheels, an operator's compartment, steering mechanism, and a universal plate for a bulldozer blade and other attachments. The 8,500-pound rear section has powered wheels, a 250-horsepower diesel engine, auxiliary power, and a SAE mounting plate for a towing winch, crane, backhoe, and other attachments.

Between these two an auxiliary section may be attached to make the unit a specialized piece of equipment. These auxiliary center sections come in various forms such as a scraper bowl, grader, compactor, membrane layer, flat-bed trailer, and tanker.

BEST equipment with scraper and grader sections in the middle were used in the exercise. They were equipped with either bulldozer or front loading buckets. The complete family of equipment will be evaluated in the full-scale division test this fall.

OTHER INNOVATIONS

Many other innovations were seen in HAWK STAR I. Special light vehicles, nicknamed the IMP by the troops, were used. This is a small tracked vehicle lighter than the MULE but, because of its track, able to move over terrain prohibitive to the MULE.

By matching tools needed with the equipment used, air assault units have drastically reduced the weight of repair vans to about 3 tons. S-141 Evaluation Mobile Containers (MOCON) are used to house certain critical supplies and act as repair vans. These containers weigh about 5,000 pounds and are air-transportable. They can be ganged together to form a large repair shop.

"Mission bundles" were airlifted into the battle area during the exercise. Each unit in the division has a series of preplanned lists which help them tailor supplies needed for a specific mission. These supplies are assembled in a bundle and picked up by aircraft and either delivered with the troops or shortly afterwards.

In the larger airstrips located many miles from the combat area, small "scooters" were used as "follow me" vehicles.

In spite of many experiments, it has been found that forklift trucks are still the quickest and easiest way of lifting supplies into aircraft. However, the heavy type forklift truck has been eliminated in favor of special light equipment.

A three wheeler "Belgian Mule" was also tried out in HAWK STAR I. The Belgian counterpart to the U. S. Army MULE seats three people in a make-shift seat. It is an open air vehicle and has a 15-hp, 2-cylinder engine. It uses a mixture of gas and oil for fuel, gets 40 mpg, and speeds up to 35 mph.

A concept of making an "instant helipad" is being studied by one of the units in the 11th Air Assault Division. To construct a helipad in a heavily wooded area, an engineer squad rappels from a helicopter into the inaccessible area with preset demolitions and chain saws. A ring of explosives is placed around trees and other obstacles, set off simultaneously, and the clearing is then finished with the saws. Using this method it should take about 10 minutes to make a usable helipad.

HAWK STAR I gave the 11th additional experience in airmobile tactics and employment. It was also an exercise in ingenuity. A new look was taken at old problems. Developmental and off-the-shelf equipment was further evaluated and new ideas were born to help the division in its push towards a maximum of mobility and responsiveness.

The Belgian Mule is one of several experimental vehicles being used by the 11th Air Assault Division

crash sense

SHARE IT!

AN ACCOUNT OF A NEAR-ACCIDENT OR FLIGHT-HAZARD

(AR 95-29)

On 18 June 1964 (date), I was Flying (flying, taxiing) on a VFR (VFR, IFR, DVFR) clearance when I experienced (experienced, observed) a flight hazard (near-accident, flight-hazard)

THIS IS WHAT HAPPENED:

". . . Weather was VFR and not a factor. The aircraft had been in 'round the clock' maintenance in an attempt to have it ready for a move to the field a day or two earlier.

"On this day the section chief called to request that I ferry the aircraft to the field in the afternoon, pending successful accomplishment of a test flight that morning. He also requested that I attempt to accomplish a standardization checkride on another pilot in the course of the flight.

"Later in the morning, I was informed that the test flight was completed and takeoff was scheduled for 1400 hours. Our crew consisted of pilot, instructor pilot (myself) and the two crewchiefs assigned to the aircraft. The takeoff was delayed slightly to off-load some baggage and reduce our load to allowable gross weight.

"Prior to takeoff, I queried one of the crewchiefs about the maintenance performed (3rd PE) and the test flight. He stated that maintenance had been done around the clock in an attempt to get the aircraft out, and that this pressure had resulted in an abbreviated test flight in which routine checks such as prop feathering and stalls had been omitted, as no work affecting these charactertistics had been done. In view of this and the additional mission of accomplishing a checkride, I elected to repeat a complete test flight.

"Takeoff and the first hour of flight were uneventful. Approaching the field area, we climbed to 5,000 plus feet and did a complete stall series. Following this, a landing gear cycle was started. The gear did not come down so a recycle was initiated. During the recycle, a grinding noise was heard for a few seconds, and two subsequent movements of the landing gear selector failed to either extend or retract the landing gear. An airspeed check indicated that the gear position was near retracted.

"The pilot then held the aircraft in slow cruise while a crewchief removed the cover plate from the landing gear transmission. Inspection and recycle tries indicated that the landing gear was binding (probably the nose gear), and that both main gear were about 10% extended. The disengage clutch was tested and functioned properly. We decided to delay manual extension procedures pending arrival at destination and a visual check of the nose gear position.

"On arrival at the field, we asked the tower to get a qualified pilot in the tower. A visual check confirmed that all wheels were about 10% extended. Manual extension procedures were started and observation of the drive mechanism confirmed that the main gear was extending normally. There was extreme binding in the drive

(day

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system and the nose gear drive chain was jerking and catching. The gear was extended to about a 50% down position, as judged from the limit switch cam position. Another visual check was made, with all wheels reported extending normally.

"Manual extension was continued until all wheels indicated down and locked. This was confirmed with another visual check. The approach was made above normal landing speed; the aircraft was bounced on all wheels, and landing was made without incident.

"Investigation revealed that the trouble was caused by a rag wedged in the nose gear drive system under the floorboards. The rag was a very dark color and the crewchief confirmed that the floorboards had been removed and replaced during maintenance. This had been accomplished at night under conditions which could easily allow for this, in view of the rag color and the generally poor lighting available.

". . . Questioning of several other qualified U-8D pilots revealed that none of them were fully aware of the exact location of the landing gear transmission, how to remove the cover plate in flight, or what to expect to see down there.

". . . Three recommendations are offered:

"1. Recommend a greater emphasis be placed on maintenance procedures in accounting for tools, rags, etc., used in a particular job or area. This might be accomplished by means of a simple checkoff system. It should be as automatic as a surgeon counting sponges and surgical tools and it should be considered equally important.

"2. Recommend a program of re-education for all U-8D aviators . . . along the lines of what to do and how to do it in analyzing and coping with gear problems. This should include a physical exposure to the contents of the area under the right front seat, an explanation of what to look for, and a discussion of do's and don'ts on gear failure.

"3. Recommend a small tool kit be placed aboard the U-8D, accessible from the cabin, to consist of a minimum of one large screwdriver, one stub phillips head screwdriver, and one pair of common pliers."

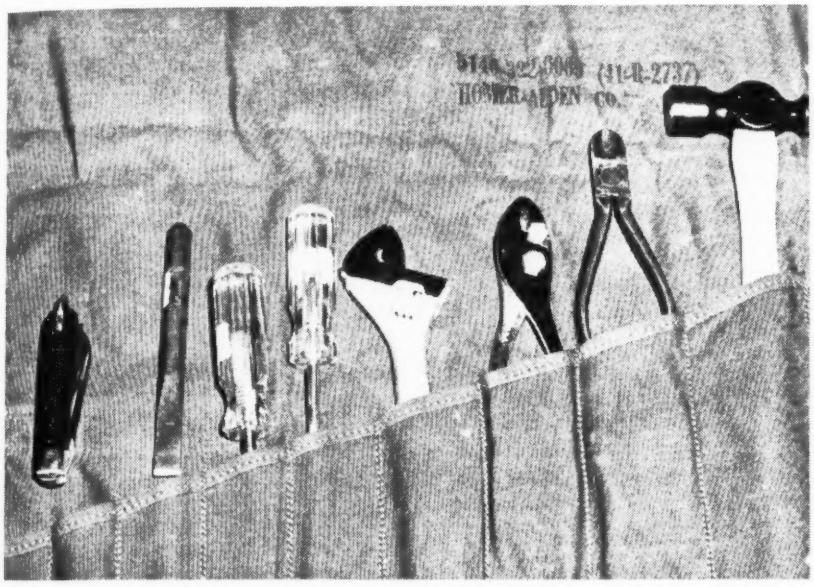
Thanks to Major Richard A Humes for SHARING this experience and his excellent recommendations. The first requires no explanation — only application. To help his second recommendation along, we suggest that you reread the "U-8 Landing Gear," October 1963 AVIATION DIGEST. ● ● ●

PROOF POSITIVE!

Crewchief models jacket worn by pilot of crashed helicopter. Burned areas show where jacket prevented burn injuries to pilot's shoulder, back, and arms.

tool kit suggestion . . .

In line with Major Humes' third recommendation, we are happy to reprint a suggestion submitted by Mr. James C. Rosser, shop superintendent, Aircraft Maintenance Division, Director of Maintenance, Fort Hood, Texas. Mr. Rosser made his suggestion after reading of a previous similar incident.



Recommended tool kit includes knife, chisel, screwdrivers, adjustable wrench, pliers, and hammer. Tools could be used for emergency repairs and survival.

Rolled tool kit installed to right of copilot's seat in U-1A. Kit is fastened by two one-inch straps with lift-the-dot fasteners.

"At the present time, there is no requirement to have tools on board DA aircraft during flight.

"During November, 1963, two pilots assigned to Fort Rucker, were on a routine proficiency flight in a U-8D aircraft. After making several takeoffs and landings, the landing gear failed to operate and the right main gear and nose gear would not come down. Fortunately, one of the pilots had a GI can opener in his flight suit pocket. Using the opener as a screwdriver, he was able to obtain limited access to the landing gear, perform an emergency repair, and make a successful landing (see CRASH SENSE, March 1964).

"Recommend that aircraft at Fort Hood and satellited stations be equipped with suitable emergency tool kits. Inclosed is a photograph of the recommended tool kit and components, which are:

1	light ball peen hammer
1	8" crescent wrench
1	8" slip joint pliers
1	8" diagonal cutting pliers
1	4" screwdriver, common
1	½" screwdriver, phillips
1	½" cold chisel
1	tool roll

"These kits should be properly secured to the aircraft and accessible to the copilot and crewchief. The kit above is recommended for the following type aircraft: U-1A, U-6, U-8, UH-1, UH-19, and CH-34, a smaller kit with fewer tools is recommended for O-1 and OH-13 aircraft. The cost of the kit described is $6.61, including the tool roll. Its weight is 3 lbs, 6 oz.

"The tool kit will also provide aircraft crew members with tools which may be helpful when forced down away from home station or when involved in an accident which requires crew members to remain in the field for an extended period of time."

The following article is slanted towards U. S. Army Aviation School instructors. However, it describes how YOU can request a training film in the field and what you can expect if assigned as film project officer at your installation.

A Film Is Born

Don Morrow

ALONG WITH the steady growth of Army Aviation a need has developed for training aids to assist in the instruction of aviators and aircraft mechanics. One of the many fine aids is a large number of training films for a particular program of instruction.

In 1955, Army Aviation could claim only one training film of its own. However, 90 films are now available for Army use, and only 11 are adopted from the United States Air Force.

The production of a training film is a costly, time consuming project. No less than 25 stages of production are involved in providing an instructor with perhaps the finest training aid

available. The steps are varied, yet each depends on the other.

A training film is usually conceived in the mind of an instructor who is making a conscious effort to improve his teaching capability and provide his students with the best training aids he has to offer. All instructors (as well as anyone else) have the authority, if not the obligation, to request a training film on any subject.

In November each year, the Training Film Liaison Officer (TFLO), Training Aids Division, Office of Director of Instruction, USAAVNS, convenes the United States Army Aviation School Film Board. This board is made up of at least one representative from each instructional department. At this meeting, the needs of the various departments are discussed, and the TFLO and department project officers are made aware of areas in which training films would assist their mission.

After this first meeting, and before 1 March, each project officer is responsible for writing and submitting a "Supporting Data Sheet" for each area on which a film is desired. This data sheet includes the proposed title, picture plan, complete justification, plus other items as outlined in AR 108-6.

All data sheets are consolidated before 1 April each year by the TFLO and forwarded to the Commanding General, Continental Army Command, as part of the annual Film and Film Strip Requirement Report.

Should a film be requested by the Aviation School that is not within its responsibility, CONARC will assign that project to the agency having primary concern. Should a film requirement become apparent after 1 April and justification indicates a critical need, a separate supporting data sheet can be forwarded at any time.

In September, the decisions are made and Army Aviation has another film program approved which will assist immeasurably in keeping our instructors supplied with fine training aids.

When notified by the Army Pictorial Center that production can begin on a certain project, YOU, the requestor, (in this case from Fort Rucker) will probably be called on to begin one of the most enjoyable experiences in Army Aviation. That experience is the assignment as technical advisor (TA) for a Department of the Army training film.

Future work with your project will be in association with a profession which is probably quite unfamiliar to you. You will be solely responsible for the material content of a training aid which will cost an average of $1,100 per viewing minute. The word "solely" should be emphasized. Many people are involved in producing a motion picture—the project officer, the writer, the TFLO to name a few. These people are deeply involved with your project at various stages, but *you* are the only person able to maintain continuity throughout the production phase.

THE WRITING PHASE

The technical advisor is not expected to write the script or the preliminary plan (treatment). A professional script writer will be assigned to the project and will work with the TA in preparing the script, or as it is sometimes called, the scenario.

Before meeting with the writer, one of your first tasks will be to consult with your department project officer to determine the scope of teaching points and to review all doctrine to be covered. This discussion will deal in detail with the supporting data sheet. At this time make sure that all procedures and doctrine to be covered in the film are supported by approved and current publications. Next, you must establish a ready reference file of pertinent FMs, TMs, lesson plans, photographs, and other related materials to assist the writer in his work. This file will usually be retained by the writer throughout the writing phase. A check must also be made for existing films made by the Navy or Air Force which are related to your subject. The writer will preview these before writing. The TFLO will help you review applicable film catalogs and request films.

When the writer arrives on post you must be available for conferences. He may have a general concept of how he will write the script, but you will probably have to familiarize him with fundamentals and governing doctrine.

The supporting data sheet will be your only guideline at this time, so far as general objectives are concerned. It will be your job to discuss, in detail, each of the objectives and give specific, detailed information regarding procedures or doctrine.

If questions regarding doctrine are not specifically answered in printed publications, immediately notify your project officer and the TFLO. They will contact agencies at other command levels and either resolve the matter or request that your project be delayed. Under no circumstances should script writ-

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Mr. Morrow is with the Training Aids Division, Director of Instruction, USAAVNS.

ing be undertaken with the hope that "the question will be answered by filming time."

The writer will first prepare a "treatment." This is a general outline of how the script will be written. It will describe the story line and general photographic approach, i.e., degree of animation, special effects, live sound or live filming.

The completed treatment will be reviewed by your department director. At this time, you can decide whether or not the correct approach is being made in script writing.

After department approval the treatment is sent to the Army Pictorial Center (APC) for approval. It will be returned in approximately three weeks and the writer will then begin writing the script. Script writing will take about two weeks.

When the draft script is completed, another meeting must be arranged with the department staff. This meeting will concern itself with the technical accuracy of the proposed scenario. The script must leave the department "letter perfect."

Once the draft scenario has received department approval the writer will send it to APC. The Army Pictorial Center's review will be concerned with the writer's use of photographic technique.

The scenario will be returned to the writer in approximately three weeks. He will coordinate with the TFLO in arranging a meeting of the USAAVNS Film Board. You will attend the boarding along with the writer. The board will review the script page by page to assure that everything covered is technically correct.

The draft scenario will then be returned to APC for binding. Approximately four weeks later a bound edition of the script stamped "Pending Production Approval" will be received at Fort Rucker. As soon as all departments make a final review of the script, plans for production can begin. This final review is a last check to assure that all previous changes have been incorporated and that no errors have been made in printing.

After forwarding final review comments to APC, an "Approved For Production" copy of the script will be received by the School. Based upon the department's ability to support the film and the availability of a film crew, production plans will be made.

ANIMATING THE FILM

Normally the animation phase will precede filming at Fort Rucker. In certain cases, however, a picture may be animated after filming is completed. The aviation project officer at APC will assist you in beginning your animation work, and he will brief you in detail on what will be expected of you during your stay. You will be taken to the Animation Branch where you will meet the animator with whom you will be working. The animator and you will initially discuss the script in general, and then he will proceed to sketch basic artwork.

After the artwork is complete, you and the animator will confer with the aviation project officer, chief of animation, and cameramen. All aspects of production are discussed, and changes are made as necessary. It is imperative that you record all approved changes in animation in your "Approved for Production" copy of the script. This script will be invaluable to you and the director during location filming. After the final conference, you will be required to sign a certificate that all the art and script is technically correct.

PREPARATION FOR PRODUCTION

The TFLO will notify you of the approximate starting date for filming and when the director and crew should arrive. Before their arrival you should have a

Actors and props must be carefully selected

detailed list of all personnel and equipment requirements. This is most easily done by listing such requirements on a scene by scene basis. For example, scene 32 may require: lead actor, two extra mechanics, one OH-13 model, olive drab with dayglow trim, one mechanic's tool set, and one inflammable waste container, appropriately marked.

If your department cannot furnish some items, contact the TFLO and he will coordinate for procurement through the Director of Instruction's office.

CASTING: Every person selected for a part in a training film must "look the part." If the scene calls for a mature, experienced mechanic, a new recruit playing the part would destroy all significance of the scene. You must provide a sizeable group of personnel for a very selective casting. A four to one ratio is a minimum. For example, if your requirement is for a cast of five, a group of 20 or more will be needed. The director will discuss with you the age, size, and general appearance standards he desires, and he will make the cast selection.

EQUIPMENT: You must assure that props furnished by your department are obtained well in advance of filming, and that all props are on the set prior to each day's filming.

LOCATIONS: Before the director arrives you should discuss with the TFLO possible filming locations for every scene. The primary consideration for any location is complete background authenticity. You must also consider the location's proximity to the main post. A location too far out in the field may pose support problems.

LOCATION SHOOTING

As soon as all items of equipment are available, filming will begin. It is your responsibility to check the props, the actor's appearance, and every move made in the film to assure that all represent accepted Army standards. Your approval of a scene represents that of the Commanding General, United States Army Aviation School. He will personally preview the film in the "answer print" stage.

In your work on the set you must r e m e m b e r that your authority does not go beyond technical aspects of the subject matter. Regardless of your personal film experience or what knowledge you have gained at APC, you are completely out of place recommending lens settings, camera angles, or other photographic techniques.

EDITING AND NARRATING THE FILM

Approximately four weeks after filming has been completed, you will be called to APC to assist in editing. During this stage the necessity of having one TA throughout the picture becomes even more apparent. When a film is spliced together, the significance of entire scenes or several scenes can be lost by deleting or inserting small portions of film. If you have followed the film all the way from the writing stage, you can explain any script deviation during filming and assure that each scene retains its original meaning.

Your final work as TA will be to assist in narrating the film. By the time you reach this stage of production your script will probably not too closely resemble the original one. Therefore, you must make sure that all scene changes have had appropriate narration changes. Sound effects will also be dubbed on, and you should be very critical of any sounds placed on the film. Most of these will be drawn from a sound library, and you may find that the library does not have accurate sound reproduction. If this is the case, the a v i a t i o n project officer should be notified and attempts made through him to obtain better sound recordings. After your narration work has been completed you will return to Fort Rucker and await the answer print review.

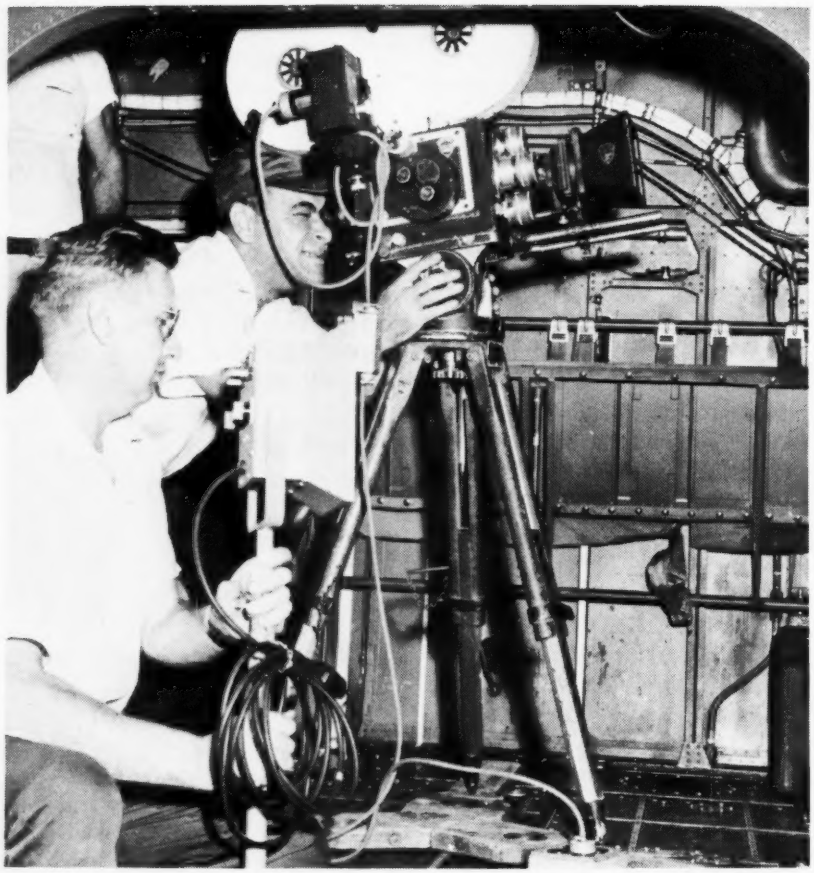
REVIEWING THE ANSWER PRINT

The answer print is a completed film, with all titles, sound, and narration. On 35mm film, it must be shown in one of the post theaters. This review constitutes final department and school approval. In addition to the r e g u l a r members of USAAVNS Film Board, invitations are also extended to the Commanding General and his staff to attend this answer print review.

If no changes are recommended after the answer print viewing, your job as technical advisor ends. Following answer print approval, the film will be returned to APC for reduction to 16mm and printing. In approximately 60 days, prints will reach the film and equipment exchange.

As one can easily see, producing a training film requires tremendous effort on the part of many people. All of these people and the funds involved are made available because YOU, the instructor, wished to provide your students with a good visual training aid. Many areas still need films as aids to better instruction. These areas will remain open until instructors request films to assist in their teaching.

The average length of time involved between an instructor's requesting a film and the



Aviation field units can use training films to advantage, but it takes time to produce one. If you think a need exists for a new film, request it now.

film becoming available is approximately 30 months. You may say, "What's the use? I won't be here to use it." As an answer, remember, if it had not been for some farsighted instructors and educational advisors, you would not have those films you are now using. Request your films. You may not use them. You may use them during future assignments here and in the field.

With few exceptions, every training film in the inventory today is also being used to great advantage by aviation field units. These same field units may also request an aviation training film. Their requests should include the same information required by a "Supporting Data Sheet." A request from outside the U. S. Army Aviation School should be forwarded to the Commandant, U. S. Army Aviation School, ATTN: AASDI, Fort Rucker, Alabama. These outside requests will be processed the same as those originating at the Aviation School.

Needless to say, unless a training film is requested, it will not be produced. Army Aviation is growing and the need for qualified personnel in the aviation field is also growing. Many areas exist where a training film would be of tremendous value. But, only YOU can request a training film.

Model "T"

THIS is the year of the OTS. During FY 1965 Army Aviation flight training centers are scheduled to receive over 300 commercial Off-The-Shelf aircraft for use as permanent training fleet aircraft.

Included in the OTS purchase will be the Sioux model T. The OH-13T is comparable to the Bell 47G-3B-1, an FAA certified civilian version helicopter.

The model T will be used by the Army for training aviators in basic helicopter instrument flying. It will allow release of more expensive aircraft to a field unit. To meet the instrument training mission profile, the Army stated a requirement for a land based rotary winged aircraft capable of takeoff and landing on any reasonable terrain with a maximum gross weight of 2,950 pounds and an out of ground effect hovering ceiling of 10,600 feet. The model T fills this requirement to a tee.

The T is powered by a 220 hp Lycoming supercharged 0-435-25, a horizontally opposed, six cylinder, air cooled reciprocating engine.

Noteworthy changes and improvements have been incorporated in the OH-13T. The main rotor blades represent a refinement of those currently in use on the OH-13S. Internal tip weights have been added to the OH-13T's main rotor blades to provide greater kinetic energy within the rotor system. The most recognizable change in the OH-13T is in the cabin area which is 8 inches wider than the cabin area of the OH-13S. The increased width readily accommodates the side by side instructor/student seating arrangement and T panel instrument presentation.

One Man's Opinion

THE HELICOPTER is an amazing assortment of nuts, bolts, rotors, push-pull rods, irreversibles, longitudinal collective differential quadrants, swash plates, wobble plates, gimbal rings, cuff and trunion assemblies, and other gadgets too numerous to mention here. All of these are welded, riveted, bolted, or sewed (sometimes wired) together to make a single machine capable of flight. In fact, it is capable of flight in any direction, backwards, forwards, sideways, up, down, and even standing still. Standing still is known as hovering. This comes in handy for those who like to fly but have no place to go.

One of the more necessary components is the engine. This unit is expected to start with ordinary fuel and change it to BTU, the BTU to BMEP, the BMEP to RPM. The RPM is then transmitted through a series of shafts and gears to the main rotor blades, which are responsible for the frantic eggbeater motion.

The engine has several important parts. Among these are the cylinders. A cylinder is a long hole covered on one end with a plate full of holes containing valves. The holes admit air, fuel, and sometimes water and carelessly misplaced tools. The other end is closed with a plug called a piston. This is free to move up and down and would come out altogether if it were not fastened to a connecting rod. The connecting rod, too, is important because it is responsible for converting your BMEP to RPM. Without it you would be left with BMEP, which no one knows how to use up to now.

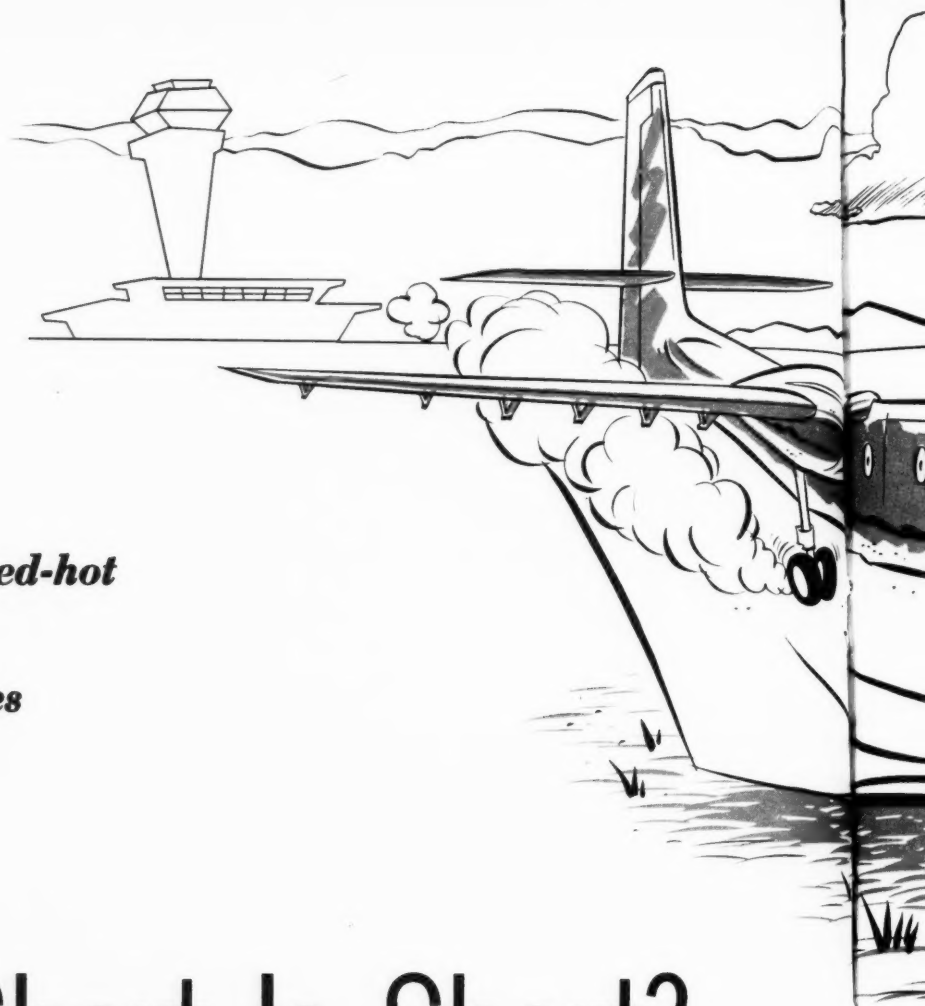
The engine power is measured in horsepower. Why? Who knows. It's often difficult to get a self-respecting horse in proximity to one of these machines. It is better to rely on instruments the electrical men have invented. They indicate power in amps, volts, or kilowatts, depending on the individual whims of the designer. With a little imagination these values can be converted to horsepower.

Starting the "thing" requires some knowledge, steady nerves, and common sense. First, make a careful check of all your instruments — both of them. This gives you a little self-confidence and adds prestige in the eyes of the onlookers.

After everything has been checked, it is safe to start the engine. If everything is as it should be, there will be a considerable noise and you will start to shake and tremble. This means the engine has started.

When your audience has returned, synchronize your eyeballs and look wisely at the instrument panel, noticing pressure, RPM, and before you forget it, check the flight controls. This is important. It is very embarrassing to get in the air and find these items not working properly or just not working at all.

Now you are ready to lift off. If you have done everything you should have, you will find to your surprise, that in spite of everything we have said the silly thing will fly.



"Are we really so red-hot in exploiting the short-field capabilities of our aircraft?"

How Short Is Short?

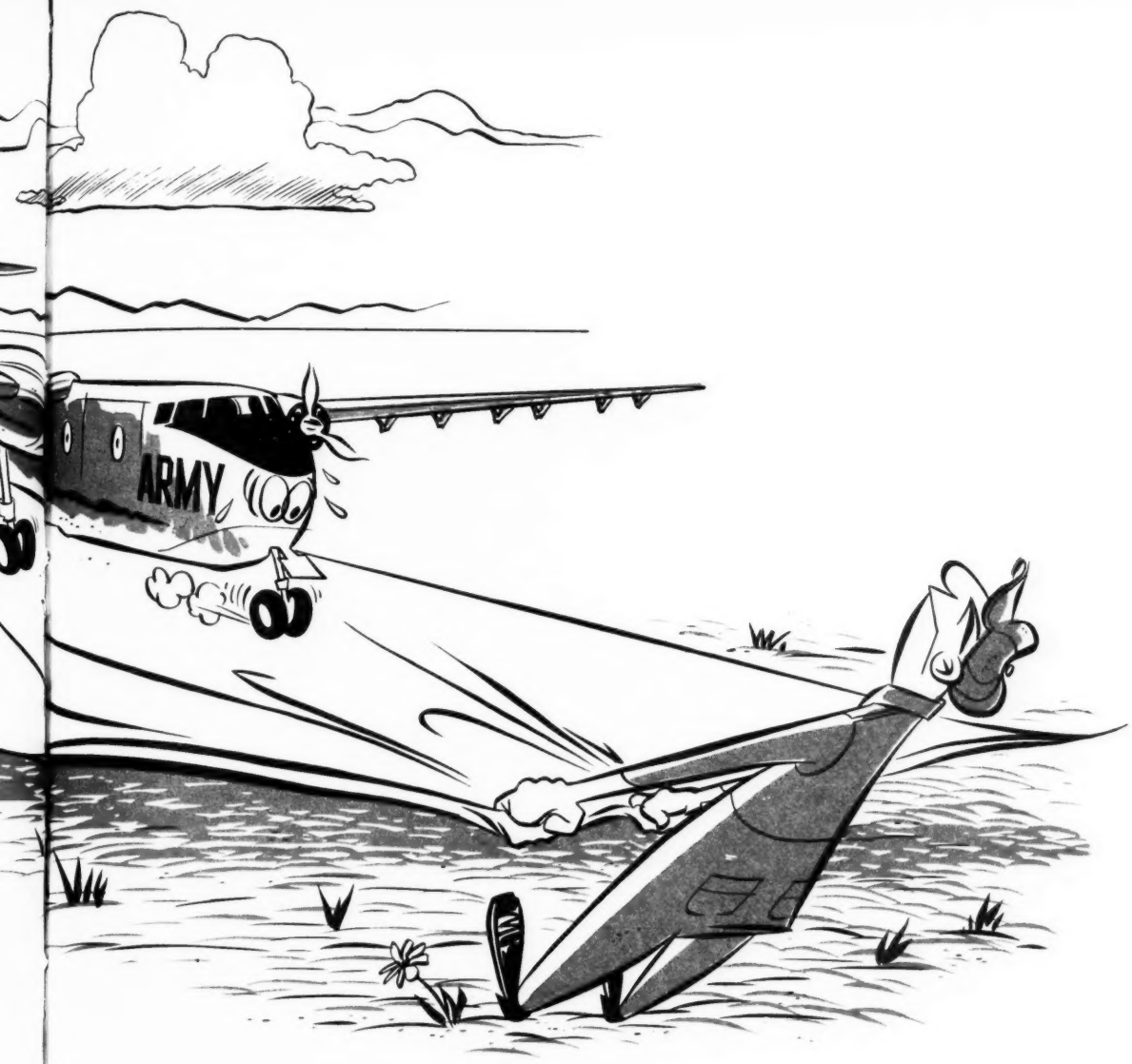
Gerard Bruggink

AFTER LOSING, within two weeks, $65,000 worth of hardware in the overrun of slippery strips, it seems permissible to ask ourselves: "Are we really so red-hot in exploiting the short-field capabilities of our aircraft?" Considering some of the circumstances stated in the accident reports, we appear to be lost in a grey area when field conditions are below the standards on which the performance charts in the operator's manuals are based. In one case, the pilot landed 400 feet long on a slick strip with partial flaps and locked the brakes during rollout. In another, the pilot stated that he did not see a connection between minimum landing roll and use of full flaps.

THE FOLLOWING DISCUSSION IS NOT INTENDED TO GIVE FINAL ANSWERS. ITS ONLY PURPOSE IS TO PROVIDE FOOD FOR THOUGHT (OR ARGUMENTS!) AND GUIDANCE FOR INTELLIGENT PRACTICE IN SHORT-FIELD LANDINGS.

THE ENERGY PICTURE

An aircraft landing is an energy-dissipating process, that is to say, the energy of motion of the aircraft has to be dissipated with *available*



means within *available stopping distance.*

Every pilot knows, or should know, that the energy level of an aircraft (its energy of motion) varies as a function of the square of the velocity: double your speed and you quadruple your energy level. He also knows that stopping distance is proportionate to energy level: double your energy level and you double your stopping distance, assuming identical braking action. What is less well known is the blunt fact that the energy level of an aircraft is determined by its speed in respect to the ground.

The best way to illustrate the relationship between groundspeed, energy level, and stopping distance is to use an extreme example in the form of a helicopter (with skid gear) making running landings at groundspeeds of 5, 10, and 15 knots respectively. The energy levels in the three cases would vary in the following proportions: 5^2, 10^2, 15^2, or 25, 100, 225. This can be simplified to 1, 4, 9. In other words, at 15 knots groundspeed the aircraft has 9 times the energy it has at 5 knots. Since stopping distance is proportionate to energy level, it is also correct to

say that the 15-knot landing requires 9 times as much stopping distance as the 5-knot landing. Increasing the landing speed from 5 to 10 knots would increase the stopping distance by a factor of four.

To shatter the popular illusion that the speed level at which we begin to reduce the aircraft's speed by a certain amount plays no role, the following statement is made without further proof: it takes as much energy (and stopping distance) to slow an aircraft from 85 to 65 knots as it does to reduce its speed from 55 to 5 knots, under otherwise identical conditions.

The implications are obvious: a minimum landing run starts with minimum energy input, which means, touchdown at minimum groundspeed. Since groundspeed depends on indicated airspeed and wind, the whole thing boils down to pilot technique. He must whittle every unnecessary knot from his touchdown IAS and exploit every little bit of wind. Needless to say that, with stopping distances at a premium, the landing roll has to start at the very beginning of the usable portion of the strip (again a matter of pilot technique).

THE EFFECT OF WIND

A pilot's best friend in short-field work is undoubtedly a strong headwind. To prove this, let us consider an aircraft with a 75-knot touchdown velocity. The aircraft is first landed with a 15-knot tailwind and then into the same wind. What would be the ratio of stopping distance in the two cases? Squaring the two groundspeeds (90 and 60 knots) we get a ratio of 8100 to 3600 or 9 to 4. This means that with similar braking techniques, the downwind landing would require 2¼ times as much landing roll as the landing into the wind.

Actually, there is hardly a pilot who'll run into trouble — and off the deep end — when he lands into a husky headwind. Even a man with a sloppy landing technique can pass the grade under those conditions. But, put the same easy-living pilot on the same strip on a CALM day and you'll be surprised at the number of items he finds wrong with the aircraft, the handbook, and his training, just because he could not grease it in without bending it.

One of the reasons this type gets in trouble is that he does not know how to handle the aircraft with finesse. When every knot and every foot of usable runway are critical, the normal slam-bam technique won't hack it. Another reason is that landing direction under very light wind conditions is often considered irrelevant. The fallacy of this attitude can easily be proved with some examples. Landing with a 3-knot tailwind would require about 23 percent more landing distance than a landing into the same wind, assuming that an aircraft has a zero-wind touchdown velocity of 50 knots. A 60-knot aircraft would need about 22 percent and a 70-knot aircraft about 19 percent more landing roll as a result of landing with instead of into a 3-knot wind.

Fortunately there is a rule of thumb that replaces all this juggling of numbers:

When the wind velocity is 10 percent of the touchdown speed, a downwind landing requires 50 percent more ground roll than a landing into the wind.

The rugged types may want to know what wind velocity it takes for a 100 percent difference between the two landing rolls. The answer is a wind velocity of about 17 percent of the aircraft's touchdown speed.

USE OF BRAKES

Brakes are sometimes referred to as "those things you stomp on when you want to stop in a hurry," an outlook that may have costly consequences. Brakes, like population pills, have their limitations. To appreciate this fact we have to dabble in elementary physics.

To slow a moving object down we have to apply decelerative force, and stopping distance is straightforward: if you want to halve the distance you have to double the stopping force. In the case of a landing aircraft, aerodynamic as well as mechanical braking action enters the picture. The latter will be discussed first because it is the most widely used.

The retarding force of brakes depends on two factors: (1) the weight of the aircraft on the wheels that have the brakes, and (2) the coefficient of friction between the tires (wheels) and the runway. The coefficient of friction is nothing but a number that tells us how much easier it is to drag an object across the ground than to lift it! For example: if it takes a 60-pound force (pull) to drag a 100-pound box over a level surface, the coefficient of friction is $^{60}/_{100} = .6$. (Note that the COF can never exceed a value of one, unless you have to do with a plowing object; in that case you are involved in an earth-moving process.)

It is generally agreed that the maximum available COF between a good set of tires (and brakes) on a dry, concrete runway is .6. However, the COF is only half of the friction formula; the other half is the weight of the aircraft. Since the lift of the wings does not suddenly disappear, just because we start to roll on terra firma, we have initially a "light" aircraft on our hands. What this means is easily illustrated. A 10,000-pound aircraft with a COF of .6 on dry concrete has a maximum retarding force of .6 x 10,000 = 6,000 pounds. Assuming that right after touchdown ¾ of the aircraft's weight is carried by the wings, the maximum available retarding force with full brakes at that time would be ¾ x 10,000 x .6 = 1,500 pounds. (In the process we have explained why it is so easy to lock the wheels immediately after touchdown.)

What can we do to get the weight of the aircraft on the wheels for maximum braking efficiency? Raising the flaps, if it can be done quickly and without interference with aircraft control, is the only answer in tailwheel-equipped aircraft. When you travel with a nosewheel you can do two things: raise the flaps *and* decrease the angle of attack of the wings by lowering the nosewheel to the ground. However, nosewheels are not equipped with brakes and all weight on them is "wasted." This is no problem for the pilot who knows his aircraft and understands what all this fuss is about. He can increase the weight on the main gear by applying aft elevator pressure (without lifting the nosewheel off the ground and jeopardizing directional control).

Braking technique itself is a wide-open subject. Some handbooks recommend intermittent use of maximum brake; others suggest constant, hard use right from touchdown. (In tailwheel-equipped aircraft the danger of a nose-over is least at the beginning of the landing roll, with the stick all the way back; therefore, the hardest use of brakes should be made at the beginning, *not* towards the end of the landing roll.) If your aircraft is not equipped with antiskid devices on the main gears, intermittent use of brakes has a definite advantage; in case you inadvertently locked the wheels, which is easily done at the beginning of the landing roll and on wet or sandy runways, it will only be of short duration and possibly prevent a blowout.

Let there be no mistake about the reduced retarding force of locked wheels. Although they leave fat skid marks on the runway and have led many accident boards to believe that the pilot did his best to keep the ship on the runway, the truth is that THE BEST BRAKING TECHNIQUE HARDLY LEAVES ANY MARKS. This does not mean that anyone who leaves a skid mark should be accused of abusing his brakes. When you approach the optimum coefficient of friction, skid marks begin to appear; however, these are easily distinguishable from the rubber-laying characteristics of a locked wheel. The most popular example in this respect is a groundloop. The aircraft begins to veer in one direction and the opposite wheel brake is triumphantly locked. Instead of increasing the drag on that wheel, it is drastically reduced, resulting in a more violent swerve.

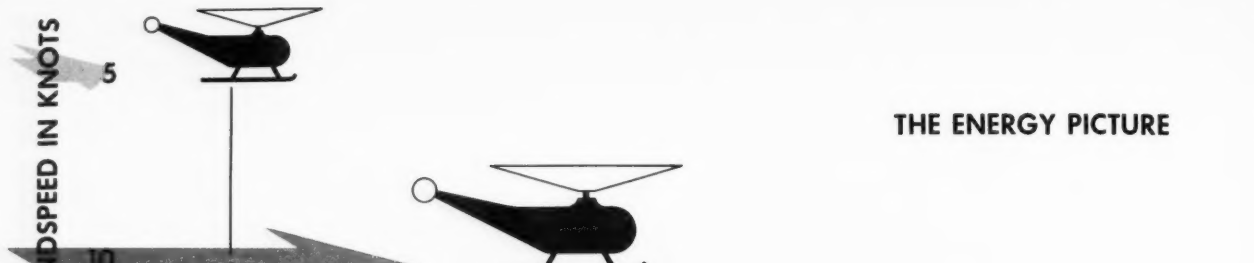
A final word about the use of brakes in aircraft not equipped with reverse thrust devices and drag chutes: The minimum landing roll on dry, hard surfaces is always associated with maximum use of brakes from the moment of touchdown till standstill, using the techniques outlined in this section. Any other method, including the one in the next section, will result in a greater landing distance. To avoid misunderstanding, and unnecessary wear and tear on the brakes, the reader is reminded that the type of landing we are discussing is an all-out effort to limit the landing roll. When excess runway is available, it would be plain cruelty to use this method, other than for training purposes.

AERODYNAMIC BRAKING

We have now reached one of aviation's many controversial issues: what technique ensures minimum landing roll when the runway surface condition is below standard (rain, snow, ice, mud, etc.)? Our handbooks are not much help. The landing performance charts are mostly based on dry runway surfaces, while special instructions seldom go beyond cryptic suggestions, such as: "Use caution when applying brakes on an ice-covered surface."

To simplify the discussion and avoid sidetracking, we'll disregard, for the time being, the use of brakes entirely and assume that aerodynamic braking is our only retarding factor. (We'll also ignore the fellows blessed with drag chutes and reversible props or thrust).

Maximum aerodynamic braking, naturally, means that the aircraft's configuration should be as "dirty" as possible at the beginning of the landing roll. You have to lower, extend, drop or dump everything that upsets the smooth contours of your machine. Conditions permitting, the landing should be made with full flaps. This lowers the touchdown speed and prevents loss of



time, tinkering with flaps after touchdown, in the speed region where aerodynamic drag is most effective.

In addition to what might be called typical drag increasers, there is the drag associated with the angle of attack of the wings. In aircraft equipped with tailwheel there is little you can do to increase this drag, once your tailwheel is on the ground. In tricycle gear aircraft, the pilot must make a deliberate attempt to keep the nosewheel off the ground as long as feasible and at least until such time that aerodynamic drag becomes negligible. Instead of letting the pilot guess at this magic moment during the rollout, it might be well to quote an authoritative source* on this subject: "at speeds less than 60 to 70 percent of the touchdown speed, aerodynamic drag is so slight as to be of little use." For practical purposes this means that in an aircraft with a touchdown speed of 60 knots, aerodynamic drag becomes negligible at 40 - 35 knots IAS and less.

But what are we going to do after we have exhausted the retarding effects of aerodynamic drag? Still proceeding on the assumption that the runway surface offers zero friction and available distance is critical, we now reach a dilemma: to cut or not to cut the engine completely? A windmilling prop with the engine at idle definitely produces high drag forces early in the landing roll. Therefore, the levers should be left alone (that is, in idle) during the aerodynamic drag portion of the landing roll. What should be done subsequently is governed by the characteristics of the aircraft.

Since an idling prop produces a certain amount of residual thrust at zero airspeed, it stands to reason that somewhere during the latter part of the rollout, in calm or no-wind conditions, a point is reached where this residual thrust begins to oppose our decelerative efforts. (Many aircraft will roll forward at idling power when the brakes are not applied and the terrain is level and smooth). Although the advantage gained by cutting the engine(s) may be infinitesimal compared to normal wheel-braking action, it may make the difference between a successful stop and a muddy mishap, when the runway surface provides no friction. Before applying this method, however, the pilot should consider other possible consequences of cutting the engine(s), such as loss of hydraulic pressure and nosewheel steering. On the other hand, it might be well to remember that an overrun without any power generally reduces the extent of damage and the fire hazard.

The best way to find out how the cutting of power will affect the latter part of the landing roll in a particular type aircraft is experimentation. This can be done without risk to personnel

* Aerodynamics for Naval Aviators, by H. H. Hurt, Jr., University of Southern Calif. (NAVWEPS OO-8OT-80)

and equipment on runways of adequate length, preferably under very light or no-wind conditions. The simulated landing rolls (with full flaps and without any use of brakes) should be started at various speeds (e. g. at 70, 60, 50, and 40 percent of the touchdown speed) and at least two runs should be made at each speed level: one with idling power, the other with the engine (s) cut. By accurately measuring and comparing all rolling distances until standstill, a conclusion will be reached concerning the possible advantage of cutting the power completely and, if such an advantage exists, the best technique to exploit it.

SLIPPERY STRIPS

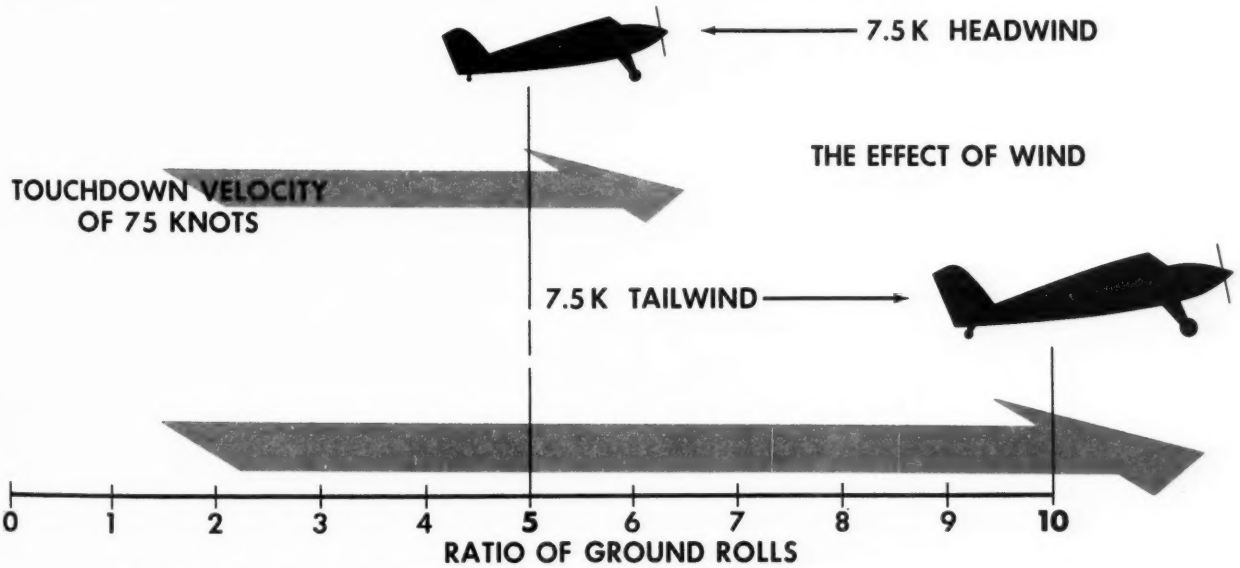
After discussing the techniques for minimum landing run under the two extremes of runway conditions, we have to face the more practical problem of determining if we can safely use a wet strip that is "comfortably marginal" when dry. Are we just going to try, hoping for the best — and raising inferno about training standards when we fail — or do we use all available means to assess the feasibility of a successful landing under these conditions?

Although the composition of field strip surfaces varies the world over, the change in surface condition of individual strips as a result of rain will generally be consistent and, therefore, predictable. Some approximation of the difference in stopping distances under dry and wet conditions can be made through experimentation along the lines suggested in the previous section. The following example is presented as a possible approach to such an experiment. (Our hypothetical aircraft is equipped with a nosewheel and has a minimum touchdown IAS of 60 knots with full flaps. It is further assumed that the desired criteria should be based on zero wind conditions).

First, we have to determine the rolling distance of the aircraft from touchdown until the indicated airspeed reaches 35 - 40 knots, *utilizing maximum aerodynamic braking only*. This can be done on any convenient calm day and on any smooth runway. The average of several runs should result in a fairly reliable figure.

Next, we have to determine the deterioration in braking action as a result of a wet runway surface. In this instance, naturally, use the strip in question, or one with identical surface, while it is wet. Since we are concerned with groundspeeds (starting at 35 knots) it is necessary to conduct this part of the experiment under zero wind conditions. This is also the time when we establish the most effective braking and directional control technique for the existing runway conditions. To avoid misinterpretation: no actual takeoffs and landings are involved in this phase of the experiment.

Finally, we add the stopping distances for the two stages of the landing roll and we arrive at a reliable estimate of the minimum landing roll under zero wind conditions on the slippery strip in question. (Changes in gross weight need consideration, but were left out of this discussion to limit its scope). Information of this nature not only facilitates the operations officer's task of mission



When the wind velocity is 10 percent of the touchdown speed, a downwind landing requires 50 percent more ground roll than a landing into the wind.

assignment and crew selection, but also increases aircraft utilization by creating a stimulating awareness of the gap between aircraft capability and crew performance.

EFFECTIVE RUNWAY LENGTH

Your operations officer sends you to a new field strip in a U-1A with the words, "They tell me the strip is a thousand feet long. Your aircraft needs only about 500. You shouldn't have any sweat."

You arrive over the strip and discover trees, about 50 feet high, on either end of the runway; the wind is calm. Still proceeding on the comfortable assumption that the runway has twice the required length, you make your approach without any misgivings and finesse. When the aircraft floats by the predetermined go-around point, you begin to feel uneasy enough to start applying power for a go-around. While you are still wondering what went wrong, the trees in front of you suddenly reach full maturity and you firewall the throttle. The engine sputters once but manages to pull the aircraft through the treetops and back to the home field. Depending on the quality of the accident board, the primary cause of this accident might be reported as "loss of power during go-around." What really happened?

A quick look at the landing distance charts of your aircraft would have revealed that under no-wind conditions, you need 1,080 feet when landing over a 50-foot obstacle. This means that a 50-FOOT TREE CUTS ABOUT 600 FEET FROM THE AVAILABLE RUNWAY LENGTH. Your effective runway length was about 500 feet. Proper approach and landing techniques, in combination with a slight headwind, should have resulted in a safe landing.

The following table of landing distances may create some respect for the effect of obstacles on effective runway length. The figures are based on no-wind condition and are not representative for all weight configurations of the aircraft involved.

AIRCRAFT	GROUND ROLL DISTANCE IN FEET	
	NORMAL	TO CLEAR 50 FT. OBSTACLE
O-1	260	**550**
OV-1	450	**870**
U-1A	480	**1080**
CV-2	470	**950**

This type of information is also useful when you have to decide between a landing into the wind, across obstacles, or a downwind landing with an obstacle-free approach.

CONCLUSION

Since there was no intent to teach, some generalizations may be more appropriate than a summary of this discussion.

- The landing distance charts in the handbooks are based on optimum techniques and conditions and may not be compatible with our procedures. Unless you know that your performance at least matches that of the handbook, do not use these charts for planning purposes in confined strips.
- To keep your short-field landing capability up to par, plan your approach, once in a while, as if strip length were critical.
- The risk of landing short must be measured against possible hazards such as the physical condition of the overruns and the wind. When the terrain at the approach end of the runway is bad, keep in mind that it may be better to run off the end of the runway at low speed than to make a high-speed touchdown in unsuitable terrain. Maintain a safe margin above stalling speed, preferably with power, during approaches in strong or gusty winds. As long as you land into a strong headwind there is no need to come in on the ragged edge anyhow.
- When you reach the desired touchdown point and a go-around is not feasible, set the aircraft down, regardless of any excess speed. Don't try to bleed off airspeed by keeping the aircraft off the ground; a rolling aircraft decelerates faster than one that is floating.

Finally, a story with a moral. Some years ago a jet base in Western Europe experienced a landing accident practically every time rain soaked the runway. Engineering experts studied the effects of water on that runway and made friction tests; the results revealed nothing that was not known already. When all other attempts failed, a brave soul suggested a change in the landing pattern from 360° overhead "tiger" break to a wider pattern with a downwind leg. That change in procedures stopped all excitement and mishaps on the wet runway. The reason? The more conventional pattern provided even the less experienced pilots with an opportunity to set up a precision approach and landing.

Mr. Bruggink is an air safety investigator with the Investigation Division of USABAAR.

The ship skipper and aircraft pilot have in common absolute, total responsibility

Of Mains'ls and Wings

WO James R. Groover

EACH TIME AN aviator refers to an aircraft as a "ship," he pays unconscious tribute to a great heritage of knowledge, observation, and word usage which existed, readily and immediately usable, for the earliest airmen, and which has since served aviation as a rich background and tradition: the heritage of the seafarer.

For centuries before the airplane, men and their commerce had been transported over the surface of the earth by the dynamic action of air moving over airfoils . . . airfoils called sails. Clumsy at first, several thousand years ago, sailing was refined through use by generation after generation. The fluid movement of the atmosphere was put to work, channelized across beautifully curved stretches of canvas, producing great pressures and partial vacuums, minutely controlled by cunning arrangements of sheets and halliards and shrouds and stays, to drive the longboats, caravels and clippers through the seas.

The sailor worked with the forces of moving air, as does the aviator of today; he moved a heavy vehicle over long distances by means of these forces, as does the aviator; and, over a long span of time, he developed much of the terminology and the beginnings of the technology used by modern aviation.

Expressions common to both nautical and aeronautical conversation are many, having been so easily adapted from sailingcraft to aircraft: forward and aft, windward and leeward, yaw, pitch, roll, mooring, rudder, knots, hold, hatch, red and green running lights . . . and on and on.

But of deeper significance than common expressions are common methods of proceeding over great distances, dealing with the atmospheric phenomena encountered, and with the human tasks and the discipline required during the voyage and the flight.

The sailor ventured to sea cautiously and none too fearlessly at first, hugging the shoreline; there were no highways on the oceans. He began to draw crude charts and to log prominent landmarks. He developed first the techniques of "pilotage" from one place to another. As he grew more familiar with his surroundings, its areas, currents and dangers, and more adept at mathematics and chart-making, he began to navigate by "dead reckoning." Finally, due to great advances in astronomy and optics, he used "celestial navigation." Each of these methods, developed and perfected at sea, are absolutely vital to modern aeronautical navigation.

From earliest times, the seagoing vessel was intensely vulnerable to the effects of weather. The seaman's life, to a far greater extent than the landsman's, depended upon his ability to interpret the signs painted across the skies in the form of clouds, to forecast the weather, and to cope with it effectively. Today's effective weather services for airmen, and the airman's own acute awareness of atmospheric occurrences, are based upon foundations of fundamental weather lore discovered, developed, and used on the quarterdeck and in the fo'c'sle.

Neither at sea nor in the air can a democracy exist. Decisions cannot be made by committee nor by popular vote; the final word is given by the one man in command, and his word is absolute law. Command at sea was vested in the master of the vessel. He was responsible for the success of the voyage, and chosen for his ability to assume that responsibility. Following this ancient tradition as the only workable solution to discipline and decision-making, the pilot of any aircraft is in sole command and solely responsible for the success of the flight and the mission. Under sail or soaring aloft, the professional brings to the task conscientious application and continuing self-study.

Far more than meets the casual glance, aviation grew with the language of the sea on its lips — the weather eye of the sailor surveying the horizon, treading the almost forgotten footsteps of a sea captain pacing the decks of a heeling, surging brigantine. . . .

WO Groover was a member of class 64-3W, Rotary Wing, USAAVNS when he wrote this article.

Writing Awards Presentation

On behalf of her late husband, Mrs. Edward Cribb accepts the U. S. ARMY AVIATION DIGEST Annual Writing Awards Contest first prize of $125.00. Making the presentation at Fort Benning, Ga., is Maj Gen Harry W. O. Kinnard, Commanding General, 11th Air Assault Division. Captain Cribb was killed in the Republic of Vietnam last summer. His award - winning article, "Ejection Over Enemy Territory," appeared in the August 1963 issue of the DIGEST.

Captain Robert W. McCaskey holds a check for $75.00 presented by Maj Gen Ned D. Moore, Commanding General, U. S. Army Alaska, for taking second place honors in the DIGEST's Annual Writing Awards Contest. The presentation took place at Fort Richardson, Alaska, where Captain McCaskey is stationed with the 19th Aviation Battalion. Captain McCaskey's article, "Use Them All," appeared in March 1964.

Maj Milton P. Cherne (right), who took third place honors in the DIGEST's Annual Writing Awards Contest, receives a check for $50.00 from Maj Gen Clifton F. von Kann, Commanding General, U. S. Army Aviation Center, Fort Rucker, Ala. Major Cherne is assigned to the U. S. Army Combat Development Command Aviation Agency, Fort Rucker. His article, "I Love My Golden Voice," appeared in May 1964.